

ANNUAL REPORT 1961 - 1962

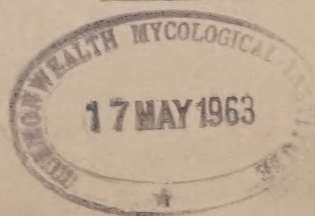
RESEARCH AND SPECIALIST SERVICES

MINISTRY OF AGRICULTURE

SAMARU
NORTHERN NIGERIA

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INTRODUCTION

The year under review has been one of achievement and this reflects the loyalty and hard work so willingly supplied by both past and present staff of the Research Division. During the year no less than six projects have yielded primary results, which, when applied, will more than cover the cost of the ten year research programme; no small compliment to the farsighted planners of a decade past.

Plant breeding work in the field of staple food crops has been concentrated on sorghum and for the first time nuclear stocks of improved local selections have been distributed to the main producing areas for demonstration and multiplication. The cultivars KYG 60 and SF 60 have yielded 5 to 66 per cent more than local varieties in outstation yield trials and if a mere quarter of this increase is obtained under local farmers' conditions, it will result in an increased production of 100,000 tons per annum of the staple food crop, worth more than £2 million. The value of such research has been well appreciated and to accelerate and expand the programme a Rockefeller grant of \$350,000 has combined with the Government's contribution of £51,000 to initiate a cereals research programme involving fourteen specialists in one of the largest projects of its kind in Africa. Plant breeding techniques have also produced dividends on the national cash crops during the year; recommendations and distribution of nuclear stocks of improved groundnuts yielding 5 to 25 per cent more than local varieties have been made. New selections of the improved cotton strain 26 J have been injected into the multiplication scheme centred at Daudawa and for the second year in succession the Physiology Section has achieved yields of over 2,500 lb of seed cotton per acre with this crop.

Such yield increases cannot be maintained without the results from parallel agronomic investigations, and in this field too, early work has been completed with fruitful results. The completion of a four years series of fertilizer trials on groundnuts, a total of 164 in all, has enabled the Agronomy Section to make various recommendations for the use of superphosphate on this crop in the different groundnut growing zones of the country. These recommendations, if used by the more northern groundnut farmers alone would result in a national profit of more than £2 million per annum.

In view of the fact that Animal Husbandry and Pasture work in future will be the responsibility of the Ministry of Animals and Forest Resources, it has been considered advisable to expand the last report of this section. The results obtained by this section speak for themselves; the fact that it is now possible to rear a male White Fulani animal to a liveweight of more than 900 lb at less than three years being a major step forward in the field of livestock production.

Staff have been needed to produce these results and it is a regrettable fact that the rather large numbers of resignations have not been fully made up by new recruitment. The Pasture Section has suffered particularly in this respect. Despite these losses the number of publications from the Division continues to increase and it is a pleasure to record the twenty-five articles

produced during the year, almost doubling the 1960 output.

Visitors, both technical and non technical, continue to be welcome to the Division, the total number of names added to the station's visitors book during the year being 361, an average of approximately one visitor per day. Among the many distinguished personalities who visited Samaru during the period were:

April, 1960	Sir Alexander Carr-Saunders, K.B.E., Inter-University Council.
June	The Emir of Kano.
July	Alhaji Abubakar Imam, O.B.E., Chairman of the Public Service Commission, Northern Nigeria.
August	Visiting party from the U.S.S.R. Mr. Justice G.B.A. Coker. The High Commissioner for India.
September	The High Commissioner for Rhodesia and Nyasaland. The Japanese Ambassador. Mr. W. Rarlston, Dept. of Technical Cooperation, London.
October	Visiting party from Japan. Mr. J.C.F. Hopkins, D.Sc., Commonwealth Mycological Institute, U.K. Mr. E.O. Pearson, M.A., Commonwealth Institute of Entomology, U.K. Mr. A.H. Moseman, Technical Director, Rockefeller Foundation, U.S.A.
November	Mr. D.F. Ruston, Director, Empire Cotton Growing Corporation, London. Mr. H. Greene, D.Sc., Rothamstead Experimental Station, U.K. The President of the Niger Republic. Visiting party from the United Arab Republic.
December	Sir Julian Huxley, F.R.S. Aminu Kano, President-General, N.E.P.U.
January, 1962	Members of the Federal and Western Region Public Service Commissions. The Emir of Argungu. The Emir of Lapai. The Emir of Lafia. The Emir of Fika. The Emir of Nassarawa. The Aku of Wukari. Malam Rwang Pam, M.B.E., Sarkin Jos.
February	Viscount Hinchinbrooke, M.P. The Earl of Derby, M.C.

The Minister of Agriculture and the Resident, Zaria Province, have paid several visits to the Research Station and there have also been visits from officials of the offices of the High Commissioners for Britain and Canada.

The introduction of the 1961 annual report would not be complete without mention of the future of the Division. In all probability the present report will be the last of the Division as at present constituted, legislation already having been passed to enable the organisation to become the Agricultural Research Institute of the University of Northern Nigeria. The transfer of assets is scheduled to take place in 1962 and it is hoped that the new organisation will carry on the agricultural research programme so ably commenced by specialist officers of the Ministry of Agriculture.

AGRONOMY

Introduction

As in the previous year the emphasis in the Agronomy Section's programme has been on the continuance of the region-wide series of fertiliser experiments on the major crops. A total of 143 annual fertiliser trials was carried out during the year. In addition, the section is responsible for the conduct of all permanent manurial and rotation experiments located at Samaru, at the Research Sub-stations at Kano and Mokwa, and at other main farm centres of the Ministry of Agriculture. There is a total of 33 such trials.

Other work undertaken by the section during the season has included sorghum and groundnut population experiments, a sorghum establishment trial, crop sequence experiments and trials on the time and method of application of fertiliser.

Fertiliser Trials

A numerical summary of the fertiliser trials carried out over the past 10 years is presented in Table I. The number of trials carried out each year has increased steadily since 1955.

TABLE I. Summary of the number of fertiliser trials conducted on the main crops of the Northern Region.

C R O P	Y E A R S										
	52	53	54	55	56	57	58	59	60	61	
Groundnut	5	14	17	6	4	13	17	31	37	42	186
Sorghum	5	1	5	10	8	15	7	6	4	26	87
Maize (a)	-	-	-	-	4	2	1	3	4	14	28
* (b) Ilorin series	18	6	6	4	6	6	3	2	1	-	52
Soyabean	-	-	1	1	2	4	5	11	11	11	46
Cotton (a) Unsprayed	3	3	4	1	3	2	3	3	9	14	45
(b) Sprayed	-	-	-	-	-	-	-	-	9	14	23
Rice	-	-	-	-	6	14	12	11	10	6	59
Upland Rice	-	-	-	-	-	-	-	7	6	3	16
Yams (a) Ilorin	9	9	6	5	5	5	3	3	-	1	46
(b) Elsewhere	-	-	-	1	3	7	14	9	6	5	44
Millet	-	-	-	-	-	-	-	-	-	8	8
TOTAL	37	30	35	21	38	67	64	88	92	143	

* Interplanted with sorghum.

Groundnut trials account for a large proportion of the total number of experiments but it is hoped that with the 1961 results available it will be possible to reduce the number of these trials to permit a further increase in number of experiments on cereals and cotton.

In 1959 soil samples were obtained from each of the fertiliser trial sites, before the fertiliser treatments were applied. No samples were obtained in the 1960-.. season but they were again taken from all the annual trials in 1961. From every site two 0-6 inch samples were taken from each of the proposed experimental plots and these were bulked, mixed and sub-divided to give a composite surface sample from the experimental area. In addition

samples were collected at regular intervals down a two feet deep profile from a pit adjacent to each site. After a mechanical analysis, chemical determinations were made on these soils for per cent organic carbon, per cent nitrogen, total phosphorus, organic phosphorus, sulphur, exchangeable bases, cation exchange capacity and base saturation.

The laboratory work is still in progress and the results will be studied in relation to the field crop data when both are available. Similar data collected in 1959 proved valuable but the total number of experiments on any one crop for which both field and laboratory data were available was relatively small. With the added information from 143 fertilizer trials in 1961, it will be possible to make a more complete study of soil character, crop yields and responses to fertilizer.

(a) Groundnuts

With the results from 42 trials in 1961 now completed, it has been possible, from an examination of the data accumulated over the past ten years, to make specific recommendations for the use of superphosphate on groundnuts in different parts of Northern Nigeria. Previously there had been too few trial results available to permit such a detailed review. It is now possible to predict, with some certainty, the mean response which can be expected in each of four groundnut fertilizer response areas into which the country has been divided. An account of this work will be published elsewhere in full detail.

(b) Soyabeans

Soyabeans are of increasing importance as a substitute cash crop in the Riverain Provinces where rosette disease and weather conditions at harvest make the successful cultivation of groundnuts difficult. Although only a few trials have been completed, the results are encouraging and the requirements of the crop appear to be very similar to those of groundnuts. The results suggest that the responses which have been obtained to superphosphate are, as with groundnuts, attributable at least in part to the effect of sulphur.

(c) Cotton

Provinces. This is the second year of a new series of provincial fertilizer trials on cotton. As in 1960, each trial consisted of a sprayed and unsprayed half, each a complete trial in itself. Fourteen pairs of trials were carried out during the season.

Earlier fertilizer work on cotton at Daudawa and Samaru did not give very promising results and a small dressing of superphosphate was all that could be recommended. With the protection of insecticidal sprays, good responses have been obtained with combined dressings of superphosphate and sulphate of ammonia, particularly at the main experimental centres where trials are closely supervised. In outstation trials the results have been less encouraging, particularly in the 1961 season and there is some doubt about the adequacy of the spraying practice adopted to provide the protection required at some of the trial sites.

Stalk weights have been recorded after picking has been completed to give an indication of the plant response to fertilizer. In sprayed trials it is normally expected that an increase in stalk weight will be accompanied by an increase in the yield of seed cotton; the same is not generally true in unsprayed trials or those trials where the insecticide has given insufficient protection from pests.

Samaru and Mokwa. The trials at Samaru and Mokwa tested higher dressings of fertilizer than in the provinces. The trial at Samaru was given nine sprayings at weekly intervals, instead of the six applied at Mokwa and on other outstation trials. The responses and yields have justified the higher rates of application and it appears from the results of these trials that the levels of both spray and fertilizer should be raised in future experiments in the outstation series.

(d) Sorghum

The increase in the number of sorghum trials has been confined to the northern part of the country. Earlier results from the Riverain Provinces and from Southern Division of Plateau Province, where most of the work was done, did not give very encouraging results. In the present trials, most of which are in the Sudan Savanna zone, between 11°N and 13°N , the yields and responses are higher. A total of 26 experiments was carried out during the season.

The two trials conducted in 1960, to test whether responses to the high level of sulphate of ammonia could be improved by applying the fertilizer in split dressings rather than as one application shortly after planting, were repeated at Samaru and Kafinsoli. The results are not yet complete but they do not appear to indicate that there is an appreciable benefit to be derived from split applications even on freely drained sandy soils.

(e) Maize

With the improved maize varieties now available, both yields and responses to fertilizer are very much higher than were obtainable only a few years ago using local material. Fourteen trials have been carried out this year in the Riverain Provinces. The mean yield without fertilizer was 931 lb per acre of grain and the mean increase obtained with dressings of 1 cwt sulphate of ammonia plus 1 cwt superphosphate per acre was 510 lb grain per acre.

(f) Millet

Comparatively little work has been done in the past on the fertilizer requirements of millet and in view of the importance of this crop, particularly in the more northern areas, a programme to remedy this omission has been initiated. As a start to the programme eight trials were laid down in 1961 season, two each in Benue, Kano, Katsina and Sokoto Provinces. The results have so far been very satisfactory, showing a response to phosphate in almost every case and in most instances response to nitrogen once the phosphate requirements had been met. It is intended to continue and if possible expand this series of trials.

(g) Yams

Four trials were planted in November, 1950, for harvest at the end of 1961 season. Two of these trials, in Igala Division of Kabba Province, included a potash fertilizer treatment, the soils being similar to those in Eastern Nigeria where potash responses have been demonstrated. The remaining trials in Adamawa and Ilorin Provinces were simple nitrogen and phosphate trials.

(h) Rice.

Trials on swamp rice were carried out at Lowlands Farm (Plateau Province), Maiduguri (Borno Province), Donga (Benue Province) and Maigana (Zaria Province). The trials at Lowlands

Farm showed, as in the past, a large response to superphosphate. In addition to a repeat trial being laid down on this site, residual trials were conducted on the sites of the 1958, 1959 and 1960 trials. A three-year trial was also started this season with the object of providing a more accurate comparison between the direct first-year and second-year residual effect than can be obtained from present comparisons which involve different sites.

At other centres, if there was any response to fertilisers at all, it was to sulphate of ammonia. Many experiments have been unsatisfactory because of lack of adequate water control.

(i) Tobacco

As in the past two seasons, assistance was given to the Experimental Officer of the Nigerian Tobacco Company, in the preparation of experimental layouts for trials at Maigana and Sokoto. All field work was undertaken by Nigerian Tobacco Staff, but further assistance will be given in processing the data when the leaf has been cured and final yields recorded.

(j) Sugar Cane

For the past two seasons there has been only one fertiliser trial on sugar cane, at Maigana. The results this year have again shown a large response to combined applications of nitrogen and phosphate fertilisers.

Long term fertility trials

Only a small number of the existing long term fertility trials in the Northern Region were started more than five years ago. The D.N.P.K. trials at Kano, Samaru and Yandev (Benue Province) and the fallow trial at Samaru are all survivors of a much larger number of similar trials begun eleven or twelve years ago. They had become extremely valuable sites, providing as they do, information on the changes occurring after prolonged application of the treatments under test. Until recently only yield data had been recorded on these experiments but the information they give can be increased appreciably by a more detailed examination of the changes which occur in the soil under the various treatments. To this end soil samples have been taken from each of the 81 plots of the Samaru D.N.P.K. trial and it is intended to obtain corresponding samples from the Kano and Yandev trials at the end of the season.

From the length of fallow trial at Samaru now in its twelfth year, samples have been taken of the produce obtained from the cropped plots. Together with samples of the fallow herbage and soil, they will be examined in the laboratory with the object of obtaining information on the cycle of nutrients between fallow and soil and how the treatments affect the rate of removal of the major crop nutrients.

With the exception of one other manurial trial at Samaru, most of the remaining experiments have been laid down within the last three or four years. Ten of these relatively new trials are designed to test on a rotation of crops, different manurial and fertiliser practices which from the results of the D.N.P.K. and other experiments it appears would be practicable in a continuous system of cropping.

A new long term trial was laid down at Samaru during the season with the object of testing the decline in the residual effect of superphosphate when used in the presence and absence of organic manure. The land on which this trial has been sited is typical of the phosphate deficient soils of the Northern Region on which much of the work in determining the response to fertiliser has been done. Having determined the dressings required initially on these soils it is essential to know how frequently they have to be repeated. The new trial is designed to provide an essential

part of this information.

Rotations

In addition to the permanent monocropping versus rotation trial at Samaru, the four crop sequence trials were continued at provincial stations. The most outstanding point on rotational practice that has emerged from these and other trials has been the reduction in yield that ensues when one sorghum crop follows another. Details of some of these results were reported in the Ministry of Agriculture 'Newsletter' No. 23 of July 1960.

A new trial was laid down at Samaru in 1961, to test whether the adverse effect is as severe when, as is the case on most farmers' land, sorghum is intercropped.

Population Studies.

Two sorghum population trials, first laid down in 1960, were repeated in 1961. In one a tall moderately tillering variety was used and in the other a short stemmed freely tillering variety. The population range covered was in each case from approximately 7,000 plants per acre to just over 58,000 plants per acre. In both years and with both varieties and at all fertility levels there was a decline in yield as the population increased from the lowest level. The chief factor contributing to this effect was the reduction in the size of individual heads, which more than compensated for the increased number of heads at the higher populations. The population adopted in routine field work on experimental farms throughout the Region is generally about 14,500 plants per acre.

The groundnut population trial was also repeated in 1961. The trial was carried out on three ft. ridges with population densities varying from 9,680 plants per acre to 58,000 plants per acre. The manurial treatments were the three levels of superphosphate included in the fertiliser trial programme.

The results indicated, as in 1960, that there was little advantage to be gained from high population densities in respect of yield of kernels per acre, though a reduction in the yield of haulms per acre could be expected at the lower populations.

The application of superphosphate gave increases in both kernel and haulm yields at all population levels.

P.R. Goldsworthy, R.M. Meredith.

BOTANY

Cereals

(a) Sorghum

Sorghums in Nigeria are grown during a relatively long wet season and so far exotic varieties have not performed well under these conditions. Nevertheless, several new collections were studied in 1961 because the assessment of new material and the maintenance of a fairly large gene pool is important. A collection from the U.S.A. (O.J. Webster, Lincoln, Nebraska) included selections derived from the cross Shallu x Combine Kafir and several Kaoliangs. The selections grew well but headed during the rains, approximately 60 days after planting. The grain type appears acceptable but at Samaru the quality was severely affected by weathering and fungal attack. This should not affect these sorghums in areas further

north where they will be tested in 1962. Other collections which were studied came from India (K.O. Rha hie, Rockefeller Foundation) East Africa (H. Doggett, E.A.A.F.R.O., Uganda) and the U.S.A. (commercial companies). Collections from Samaru were sent to several countries.

Selection work within adapted local material was continued and strains were tested in provincial trials.

At Samaru, the centre for selection work in the Northern Guinea Savanna Zone, yields from Guineensis selections ranged between 1,000 and 2,000 lb per acre with significant differences between and within families. Strains under trial in the provinces performed well and in some trials outyielded the local control varieties by 44 per cent. For the first time material was released for multiplication and distribution to farmers.

Selection was continued also within Short Kaura, a high yielding Caffra type with a yellow endosperm. This variety is becoming more popular although the white grained lower yielding Guineensis sorghum will occupy first place.

Further north in the Sub-Sudan Savanna Zone, where Caffra sorghums are more important, selections made at Kano from Yar Gunki performed well in provincial trials. Yield increases ranged between 11 per cent and 66 per cent and material was released for multiplication in 1962. Selection work continued at two other centres, Maiduguri and Mokwa but the programmes are at an early testing stage.

Most of the breeding programmes at Samaru are in an early stage with progenies in the F_1 to F_3 stage. Crosses have been made to combine desirable characters from the two major Nigerian groups particularly with a view to extending the area now growing Caffra sorghums. Selections from the cross Hegare x local Guineensis and Combine Kafir x local Guineensis in 1951 outyielded the best Caffra selections but they are not entirely satisfactory because they are difficult to thresh and the grain size is small.

A series of wide crosses between different geographic "races" and local varieties was made with a view to examining the agronomic characters of the F_1 . This project, together with a search for male sterile "producers" among the local populations forms a basis for work leading to the production of suitable hybrid sorghums.

Preliminary genecological trials revealed that an important factor in determining the suitability of a variety for an area was the time of heading in relation to the length of the rains. Duration, growth rates and yield components were studied in a sequentially planted trial comparing the varieties at two levels of fertility. A six week delay in planting hastened blooming by 34 days and 25 days respectively in the two varieties.

(b) Millet

No breeding work was carried out on this crop. Provincial trials comparing local populations were continued.

(c) Maize

Trials in co-operation with the Federal Department of Agricultural Research were carried out in several provinces and at Samaru. In addition to this programme, S_1 lines derived from Kansas - Indian material were top-crossed to a tester.

(d) Wheat

Four dry season variety trials at Goronyo, Yau, Kano and Samaru gave similar results. It would appear that although some

of the introductions is likely to give a significantly better yield than the local wheat, varieties from the Norin series or possibly Florence Aurore do not yield significantly worse and they could be substituted if necessary. The results of milling and baking tests have not yet been received.

(e) Barley.

The records from both wet and dry season trials were disappointing.

D.L. Curtis

Groundnuts

Investigational work for the Northern Provinces was continued in Kano and for the Riverain Provinces in Mokwa. Previously assessment and selection for the Riverain Provinces was done at Samaru but after the 1960 harvest the selection material was divided between Kano and Mokwa on a basis of general suitability for either the Sudan or the Southern Guinea Zones. In addition to the selection work based on Kano and Mokwa, outstation variety testing and time of planting trials continued in all provinces.

(a) Northern Provinces

During the 1961 season the following trials were carried out: twenty-two variety trials, eleven selections trials, four variety observations, two planting sequence trials and a series of observations on possible confectionary trade groundnuts.

From results of the outstation variety testing programme over the past five years the following new recommendations have been made:

Samaru 57: (Spreading Bunch, Castle Cary group) - recommended for the whole of Bauchi Province. It has been multiplied at Azare for some years where it has outyielded the local runner by 22.9 per cent over six years. At Darazo it has yielded 5.3 per cent more than the current local which is a previously issued improved spreading bunch type.

Samaru 61: (Spreading Bunch, Castle Cary group) - recommended for the Shanga area of Sokoto Province, where it has outyielded local by 15.8 per cent (three years trials) and for the Soye area of Sardauna Province. At Soye, Samaru 61 outyielded the local runner by 1.1 per cent but is popular due to its erect habit and ease of cultivation.

T37-47: (Runner, Indian group) - recommended for Sokoto West and the Birnin Kebbi area (Sokoto Province). In six trials it has outyielded the local runner by 35.9 per cent. The variety is an introduction from Bambey, Senegal.

DS569: (Runner, Natal group):- recommended for the Daura area (Katsina Province) where it was selected from local stock and has outyielded the unselected local by 10.9 per cent in three years of trial.

DS5418: (Runner, Natal group) - recommended for the Maiduguri and Marguba area (Borno Province) where it has outyielded the local runner by 15.1 per cent in four years of trial. The variety is a selection from Daura local.

Strains 396 and B187-1, two varieties of confectionary trade type, were yield tested against local and improved varieties of the normal Nigerian types suitable for the oil crushing trade. These confectionary varieties are large seeded, of hybrid origin and were obtained from the U.S.A. Strain 396 is acceptable for the salted peanut market and the acceptability of B187 - 1 is under investigation

investigation (it is plumper than strain 396 and has a pale testa). The improved spreading bunch control variety used was either Samaru 61, MK 374 or Samaru 38 according to the location of the trial. Yields are summarised in Table II.

TABLE II. Results of yield trials with confectionary type groundnuts.

Yields in lb kernels per acre

Variety	Lowlands	Langtang	Biu	Samaru	Gimi Dabosa	Darazo	Ningi	Kano	Ch...
Local	1547	982	1094	-	537	772	1417	-	16
Improved Spreading Bunch	1833	1310	1318	877	499	1177	1761	1406	16
B187-1	1671	1228	852	1138	314	770	1184	1128	16
Strain 396	-	1223	880	651	169	989	1320	894	16

* Yield per acre unshelled nuts.

Yields and shelling percentages of the confectionary varieties were generally below those of the improved spreading bunch varieties. At Langtang and Lowlands, although yields were good, harvesting took place before the end of the rains. Delayed planting to ensure dry harvesting conditions increases the rosette hazard and decreases yields. The yields of selected graded kernels per acre of confectionary nuts have not been completed and these will be required before definite conclusions can be drawn.

For the assessment of new selections, Marguba, Daura and Gume were used as testing centres representing dry Sudan Zone conditions as well as Kano which is typical of the less arid Sudan Zone. At Marguba, Bornu runner selections were tested and one of these, US 574, significantly outyielded DS5418 (the current recommendation) and all other selections. At Gume a recent Bornu selection UBU5 significantly outyielded Samaru 61 and all other varieties. No other selections tested at Gume outyielded the currently recommended Samaru 61. In Kano an extensive range of selections were tested against Samaru 61 and MS539 (Runner, Natal group) and promising lines retained for further trial. In addition a wide range of local material from the 1960 Samaru selection programme was grown and results are still being evaluated.

(b) Riverain Provinces

During 1961, eleven variety trials, four times of planting observations and fourteen variety stock plot observations were carried out at outstations. Yields differed greatly from station to station and drought with unusual rainfall distribution was responsible for virtual crop failures at Zinna, Lafia and Ilorin. At Lowlands and Jema'a rainfall was periodically very heavy while in most of the Riverain areas it was a drier than usual season with uneven rainfall distribution.

Outstation variety trial and variety observation results have confirmed that, in nearly all areas of the Riverain Provinces, Castle Cary Bunch and Kongwa Runner groups are well suited provided they are planted early. Yandev is the only station where short season varieties have been consistently successful and the variety 28-204 (ex-Senegal) is currently recommended. The hybrid introduction, Georgia Bunch Selection 207-3-1, representing the Georgia Bunch group, has now been extensively tested and has in general yielded about the same or rather less than the true long season

types. Only in Lafia has GBS 207-3-1 been spectacularly successful and it will be further tested in that area. Where first stage variety trials have indicated the suitability of long season upright and runner groups, improved selections and new varieties were again under trial. The variety MK 374 (Castle Cary Bunch) remains a general recommendation for the Riverain Provinces but at several outstations the varieties G 153 (Castle Cary Bunch ex India) and RU 544 (local Castle Cary Bunch group selection) have been significantly better. Previous indications were confirmed at Okuta where Valencia type earlies yielded rather better than other short and long season groups.

Planting sequence trials in Adamawa Province confirmed the importance of early planting, a finding previously known for the other Riverain Provinces. A late sequence planting observation at Yandev indicated that late August - September was a suitable time for planting a second short season crop. July - mid August plantings were markedly poorer than the later ones.

The Riverain Provinces selection programme was moved from Samaru to Mokwa in 1961. At Mokwa pedigree and mass selections representing a wide range of local types were tested in six trials and five observations. Sixty selections were assessed in the observation tests of which five outyielded the control variety Samaru 38 (Castle Cary Bunch group), by more than 200 lb kernels per acre (representing a 15-30 percent increase in yield). In the selections trials 48 upright strains were tested and 23 of these significantly outyielded Samaru 38 with yield increases varying from 12-35 per cent. There was a moderate consistency of performance in strains over the year of trial in Samaru and Mokwa. All the high yielding selections had a growing season of 130-140 days and were thus lifted before the end of the rains. The percentage of the crop collected as cleanings varied from 18-40 per cent. None of the very long season varieties (160 days) were comparable in yield with Samaru 38 and all introduced so-called rosette resistant varieties which showed actual resistance were of this type. Further testing of rosette resistant varieties will be continued although it appears that they do not have the yield potential of the normal 130-140 day types.

C. Harkness, R.W. Gibbon

Benniseed (*Sesamum indicum*)

During 1961 fourteen outstation planting sequence trials and four variety trials were carried out while breeding and selection work was continued at Mokwa and Yandev.

The optimum time of planting for the early benniseed crop throughout the Riverain Provinces is now established as the first three weeks after the onset of the rains. Plantings made later than this result in heavy loss of yield. The early crop is restricted to areas with a twin-peak rainfall distribution and a fairly reliable short dry spell in July - August when harvesting can be done successfully. In other areas a late crop is more suitable and trials in such areas indicate that mid August - mid September is the optimum planting period. In general, yields from the late crop have been lower than from the early crop.

Outstation variety testing showed that two new multilocular selections showed promise in Kabba Province while at Yandev and Ilorin quadrilocular local types were the most successful. The early crop in Mokwa was adversely affected by sporadic rains and a severe incidence of foliar disease. In the main selections yield trial a quadrilocular local selection V16u significantly outyielded all other hybrid selections, exotics and local selections due to its comparatively high degree of tolerance of the foliar disease. Most hybrids and exotics in the yield selection programme were susceptible to the disease and as a result of this V16u has been incorporated in

the breeding programme together with other strains which showed resistance. The use of seed dressing for control of the disease will be investigated. Further selection testing in Mokwa showed that three new selections from the breeding programme and nine local selections outyielded the currently recommended variety Yandev 55. At Yandev incidence of disease was low and selection in local stocks and assessment of previous selections continued.

W.C.Stonebridge

Soyabean (Glycine max)

Outstation work on time of planting continued and eight first stage variety observations were carried out. Selection and variety testing were continued at Mokwa and preliminary trials on plant populations were done at Mokwa and Yandev.

For most areas of the Riverain Provinces the optimum time for planting long season soyabeans has been determined and specific recommendations made. The optimum time for planting varies locally from mid-May to early July with mid-June as the most common optimum.

The outstation variety observations indicated that short season determinate varieties were less successful than long ~~season~~ indeterminate varieties in the main soyabean growing areas. A mass selection from the current standard variety Malayan was rather better than the unselected parent stock in most of these outstation trials. Short season varieties gave low yields at Mokwa due to poor establishment and severe damage by hares. The hare damage was sharply differentiated and the long season varieties were not seriously affected. In 1960 the short season varieties were not damaged by pests and markedly outyielded the long season types. Pedigree and mass selections within introduced varieties other than Malayan were not outstanding. This work will be continued in more recent bulk introductions on the basis that Malayan Mass Selection appears to be an improvement on the unselected parent. In 1960 Malayan Mass Selection outyielded the unselected parent by 38 per cent at Mokwa and the 1961 outstation variety observations indicated that the selection was rather better than the parent stock. In 1961 Mokwa variety tests the mass selection and the unselected stock yielded about the same but yields were low than in 1960. Malayan remains the currently recommended variety and was again multiplied for distribution.

W.C.Stonebridge

Grain Legumes

(a) Survey. A national survey of the distribution, agronomic practices and domestic use of grain legume crops continued.

The cowpea (Vigna sinensis) is the most important of the indigenous grain legumes and is found in most communities north of the confluence of the Rivers Niger and Benue (8th parallel).

The bambarra groundnut (Voandzeia sp.) is widespread; it shows considerable variability and it would appear to warrant investigation.

Phaseolus lunatus is widely grown as a compound crop and forms a trade crop in Southern Zaria, Plateau, Benue, Ilorin and Kabbia Provinces.

* The so-called green yam (Phaseolus aureus) shows restricted distribution. The underground cowpea (Kestingiella sp.) occurs only in Southern Zaria.

The yam bean (Sphenostylis sp.) is widely grown in the Riverain Provinces. Pisium, Canavallia and Cassipourea L. were reported as known or cultivated.

(b) Cowpeas. Although at the present time cowpeas are usually grown inter-cropped, the object of the breeding programme is to produce an acceptable variety for growing as a sole crop. Progenies of New Era x Local have been multiplied up for formal trials. Most of the introduced varieties, with some exceptions, are not locally acceptable. Among the exceptions are the "Black-eyes", two of which are recommended as an early crop which is given the same cultivation as early maize.

Two fodder varieties of the New Era type, Brabham Victor and Victor have been found superior to New Era.

(c) Other Genera. Collections of pigeon pea (Cajanus cajan) and lima beans (Phaseolus lunatus) have been maintained.

(d) Multiplication. Plots of cowpeas, Dolichos lablab, Phaseolus vulgaris and P. aureus for seed multiplication were grown successfully with irrigation during the dry season at Samaru and Maidana. Insect control measures were necessary and irrigation at ten day intervals was satisfactory. Some of the Dolichos varieties may be sensitive to day-length. Yield of cowpeas was over 1,000 lb dry grain per acre with insect control.

W.R. Stanton

Vegetable Crops

Trials to determine suitable experimental designs and the best cultivars were carried out on beans, cabbage, cauliflower, lettuce and carrots at Samaru. Yield trials were also carried out on a range of imported vegetable crops. Most of the local crops used as vegetables were maintained at Samaru, and trials were conducted on Amaranthus spp., false benniseed (Ceratotheca sesamoides) and okra (Hibiscus esculentus). Yields obtained from Amaranthus selections were good with the best ones giving more than 10,000 lb per acre fresh material. The false benniseed yields were not so high and the quality was poor.

During the year, a survey of peppers was made and of the 148 samples received, 55 belonged to Capsicum annum and the remaining ones to C. frutescens. The mean yield of fresh fruits was 1,100 lb per acre and there were no differences between species. C. frutescens which is imported, generally flowers later than C. annum, but the most important characters are pliability and retention of colour on drying.

The work on sweet potato received a severe set-back when many plants about to be dispatched for provincial trials succumbed to a suspected virus disease. The disease was most severe on hybrid material imported as seed from the U.S.A. in 1957. No material was sent out from Samaru, the plots were rogued and so far there has been no further outbreak of the disease.

Other Crops

A cassava variety (Manihot utilissima) collection was maintained at Samaru. Fifty-one samples were received from the provinces and 31 from the Federal Department of Agricultural Research.

Senna, grown from seed supplied by the Tropical Products Institute, was harvested and sent to the United Kingdom for analysis: results were disappointing. Unfortunately the crop was killed by a severe Fusarium wilt during the rains so there was no chance to

see if the percentage of active principals increased in the second harvest. A second crop has been established.

Results from sugar cane trials at Maigana confirmed that CO 30 and POJ 2725 were the best clones tested in terms of yield, ratooning ability and red rot resistance. Hard canes are not immediately acceptable to the farmer who prefers a soft cane for chewing. Six soft canes have been introduced for this purpose.

O.A. Inyang

Tree Crops

Nursery work was concentrated on the production of citrus and mango material for experiments. Paw paw (Carica papaya) seed introduced from Ibadan failed to germinate but work continued on selection within different guava types (Psidium guajava). Other introductions included the carob (Ceratonia siliqua).

The establishment of citrus rootstock trials in the provinces and at Samaru was generally good and growth measurements being taken in the different ecological zones should provide valuable information.

Several mango (Mangifera indica) trials have been established at Samaru, including a rootstock trial in which Peter, Peach and Tayma are grafted on five clonal stocks selected from Nigerian polyembryonic seed types.

A. Bruno

Physiology Studies

Studies on the physiology of the sorghum and groundnut crops commenced in 1961.

(a) Sorghum. A single field experiment was conducted in which growth analysis was carried out on three varieties at two levels of fertility and two levels of rainfall retention. Weekly samples were taken for leaf area and dry weight determination. The varieties were

Samaru Farafara	Strain 551
Short Kaura	Strain 242
Webster's Cross	Strain 26

High and low fertility treatments were equivalent to those used on maximum yield plots and their comparison plots respectively. Rainfall retention differences were set up by cross-tying furrows and vertical mulching as opposed to open furrows.

Growth analysis: Net assimilation rates during the vegetative phase of growth declined steadily for all treatments. Farafara maintained the highest rate followed by Short Kaura. These differences are explicable on the basis of varietal differences in the degree of mutual leaf shading as indicated by the relation between height and leaf area in each variety.

Webster's Cross had the highest leaf area until the last sampling interval (23rd-30th October) when the leaf area of Short Kaura was greater.

Crop growth rate was highest in Farafara during the vegetative phase, and highest in Short Kaura during the reproductive phase. In all varieties there was a decline in crop growth rate during the flowering period, followed by an increase during grain development. Relative growth rate followed the same trend as crop growth rate and was highest in Short Kaura during grain development.

High fertility was associated with higher rates for all growth functions than low fertility. Rainfall retention treatments had little effect in a year of well distributed rainfall.

The high assimilation and crop growth rates of Farafara during the vegetative phase were not associated with high yield. There is an indication that head size at exsertion is related to a high growth rate during the vegetative phase combined with a high proportion of the total tillers being fertile. Head size was the most important yield component in this study.

Table III. Yield and yield components and growth rates (gm/m² land area/week) for three sorghum varieties averaged over high and low fertility.

Component	Webster's Cross	Farafara	Short Kaura	S.E.
Heads/plant	2.47	2.06	1.57	0.08
Grains/head	2139	1986	2704	115
1000 grain wt.	20.7 gm	30.4 gm	33.5 gm	0.34
Grain yield lb/acre	2220	1716	2486	89
Growth rate vegetative	118	145	110	
Growth rate reproduction	70	95	136	
Maximum height	2.1 m	5 m	2.6 m	
Proportion fertile tillers	0.85	0.77	0.81	

b) Groundnuts. The influence of times of cross-tying furrows and vertical mulching with groundnut shell on the development and yield of Samaru 38 groundnuts was studied in observation plots in 1961. The effects of residual high and low fertility were noted.

Vertical mulching with groundnut shell tended to depress peg production during August although there were no differences in the number of nuts per plant at harvest.

Residual high fertility resulted in larger plants in mid-August with more pegs per plant. The proportion of those pegs producing mature nuts at harvest was greater under residual low fertility so that the final number of nuts per stand, mean nut weight and kernel yield, were equal at both fertility levels.

In a season of low, but well distributed rainfall, no consistent differences in observed characters were produced by water retention treatments.

W.M.Steele

PLANT PATHOLOGY

Rice

Study of the potentially serious disease of upland rice, crown sheath rot (Oribolus oryzinus), continued. The fungus was isolated both in culture and in rice seedlings from two lots of herbarium specimens of rice from Lowlands Farm; one six months old and the other eighteen months old. In both cases no viable ascospores could be found and the inoculations were made from mycelium. Although the fungus grew in culture, it appeared to be attenuated and no perithecia were formed. Perithecia were found after six weeks on rice plants inoculated sixteen weeks previously with fungus from the six months old herbarium material and it is expected that it will be possible to obtain a more vigorous isolate from the ascospores when they are mature.

The vegetative growth of O. oryzinus and its mode of attack on rice seedlings were studied. The fungus forms a loose network of mycelium on the outside surface which bears conspicuous, dark, amoeboid appresoria. On the inside of the leaf sheaths the fungus forms a fan-shaped radiating mycelium with a tendency to aggregate into mycelial strands. The fungus can also form runner hyphae on the roots in the same way as O. graminis, but the usual method of entry is at collar level, colonising the bases of the leaf sheaths in succession.

There is unconfirmed evidence that O. oryzinus is seed-borne. Seed of the upland rice variety Agbede, from Lowlands Farm, sown in unsterilised soil, gave from 1 - 2 per cent seedlings showing mycelium and appresoria apparently identical with those of O. ory. Samaru Agbede seed produced no infected seedlings when sown under the same conditions.

Attempts to infect sorghum, maize and millet (Pennisetum typhoides) with O. oryzinus showed that the fungus would grow on millet seedling leaf sheaths although there was no spread through the plant. Presumably O. oryzinus could survive on old millet seed which is of importance as millet is one of the crops likely to be used in rotation with upland rice on Lowlands Farm. The actual incidence of O. oryzinus at Lowlands Farm was less than one per cent in 1961.

Evidence of varietal susceptibility of rice to O. oryzi us was obtained in laboratory studies. Oshodi (1/56) was shown to be the most susceptible variety followed by Agbede (16/56) and BG79/ (132/54). BG79(131/54) and Agbede (140/54) appeared least susceptible.

Cultures of Piricularia oryzae and Helminthosporium oryzae from rice seedlings have been obtained for inoculation work; cultures have been sent to the Commonwealth Mycological Institute for confirmation of identification.

E. Harris, C.T. Pyne, A.S. Fa

Cotton

The rather dry conditions were unfavourable for the spread of bacterial blight (Xanthomonas malvacearum), especially in the latter half of the season. Alternaria leaf spot was serious only on late-sown cotton seedlings; Ramularia and Cercospora leaf spots were unimportant.

Seed Dressing against bacterial blight. Four organo-mercurial dust dressings, three non-mercurial dusts and four organo-mercurial liquid dressings were applied to raw 26 J seed at rates between 0.3 per cent and 1.0 per cent w/w, and sown on 8th July. None of the dressings were in any way phytotoxic and every compound was less effective than the standard dressing, Agrosan 5 W (applied at 0.67 per cent w/w) in controlling bacterial blight.

The liquid mercurial dressings proved very similar to each other, rates less than one per cent generally producing 10-15 per cent infected seedlings, although it is hoped that application rates of less than one per cent would give an acceptable degree of control if the dressings are applied by machine, rather than by hand.

Acid treated seed was additionally dressed with the four liquid dressings to discover if the small amount of residual internal infection would be reduced by the more volatile liquid dressings. The results confirmed last season's work that liquid dressings and acid treatment are to some extent additive.

Seed infestation experiments. Since 1956 seed obtained each year from different cotton markets has been grown at Samaru to compare the level of seed infestation. This gives a measure of the amount of bacterial blight in the area where the seed was grown. The highest level of infestation is in Bauchi Province and adjacent areas of neighbouring provinces. It is hoped that a second seed dressing plant will be installed at Kumo ginnery, in the centre of the area.

Plant inoculation with Xanthomonas malvacearum. Previous trials involving inoculation of plants at the growing point, spraying a culture in suspension and boll inoculation had been unsuccessful but other field inoculation methods, for example needle inoculation of the leaf midrib or of young stems below the cotyledons, had given moderately successful results. The only really satisfactory techniques have now been shown to be seed inoculation for field experiments and mid-vein inoculation for screen-house grown material.

Inoculation techniques were shown to be ineffective in the dry season as the relative humidity could not be raised above 50 per cent.

General. Trash infected with bacterial blight was shown to become sterile after exposure for period of nineteen days or more during June and July.

A disease known as stem break which causes plants to break off at soil level was again present in the heavily manured, maximum yield plot. Rhizoctonia (Corticium) solani and Sclerotium rolfsii were both consistently isolated from the diseased plants.

The fungi present on stained lint from cotton sprayed with BHC/DDT showed that there was no change in the proportion of species causing staining of unsprayed cotton.

M. Dransfield.

Tomato

Septoria lycopersici is the main factor limiting tomato production during the rains in Northern Nigeria. Infection appears to be soil-borne and spreads by rain splashing soil onto the lower leaves. Lesions first appear on the lowest leaves and spread gradually upwards by pycnidia releasing spores until the uppermost leaves are infected. Complete defoliation up to about one-third of the height of the plant, occurred frequently in severe infections.

A trial was carried out in the wet season comparing the effect of two fungicide sprays ('Coprantol' 9.4 per cent and 'Fernide' 0.8 per cent) and mulching on the variety 'Best of All' to control S. lycopersici but no significant effects were produced on yield.

Comparison of eight tomato varieties for field resistance to S. lycopersici showed the varieties 3359 and Marvel to be most resistant.

C.T. Pyne.

Potato

Alternaria solani was very severe on the variety Up-to-Date Riyom (Plateau Province) where infection reached 100 per cent on wet season crop. At Samaru, A. solani was not recorded on the variety.

A trial comparing the effect of three fungicides, Agallol, Orthocide and Verdasan, applied as dips to control fungal attack on irrigated potatoes at Samaru showed that Agallol and Orthocide each at 0.8 per cent and Verdasan at 1.6 per cent gave substantially higher stand counts than the untreated control. Yield figures are not yet available for this trial.

C.T. Pyne.

Benniseed (Sesamum indicum)

During the 1961 growing season benniseed at Mokwa was surveyed for the presence of diseases. The disease incidence in the early crop was much higher than in the late crop and this was probably caused by the fact that the early crop received some 22 inches of rain while the late crop received only four inches. In addition to examining the growing crops, bulk samples of seeds from the 1961 crop were examined for fungal contaminants. The following were recorded:

Pathogens recorded on early crop (27.4.61 to 15.8.61):

<u>Cercospora sesami</u>	On leaves
<u>Cylindrosporium sesami</u>	On leaves
<u>Alternaria</u> sp.	On leaves
<u>Fusarium</u> sp.	On leaves
<u>Oidium</u> sp.	On leaves
<u>Corynespora cassiicola</u>	On stems
<u>Pseudomonas sesami</u>	On leaves

Pathogens recorded on late crop (15.9.61 to 21.12.61):

<u>Oidium</u> sp.	On leaves
<u>Olpidiaster</u> sp.	On leaves

Fungi isolated from samples of 1960 seed:

Sclerotium bataticola
Fusarium spp.
Rhizopus stolonifer
Aspergillus niger
Aspergillus oryzae
Aspergillus terreus
Aspergillus versicolor
Penicillium spp.
Dark sterile mycelium.

The foliage diseases were very destructive on the early bennised crop the most important being caused by Cylindrosporium sesami. This pathogen, however, was generally present as part of a disease complex which involved several of the pathogens listed above. Cylindrosporium sesami commonly initiated the disease condition causing angular brown leaf-spots and several of the other pathogens, notably species of Alternaria and Fusarium, soon became established on the diseased leaves and this multiple infection led to wilting and die-back. In severe cases the die-back affected the entire plant which died.

Varietal resistance to the disease complex and to the individual components of the complex exists. Some varieties while susceptible to Cylindrosporium sesami do not develop the wilt and die-back. Of all the selections grown in Mokwa, one selection 'V16u' was markedly the most resistant. In previous years when disease attacks were much less virulent this selection was normally outyielded and its good performance in 1961 was largely due to its resistance to disease.

The fact that most of the foliage diseases recorded above can be seed-borne is of considerable importance and the question of seed dressing is being investigated.

D. McDonald.

Groundnuts

Fourteen different species of 'test plants' which have been used in the elucidation of other legume virus were grown in the greenhouse and information was recorded on establishment and number of days required from planting until leaves suitable for mechanical inoculation with virus were formed.

Three species of Cercospora were recorded on groundnuts in Mokwa; Cercospora arachidicola, C. personata and C. canescens. The most important of these during 1961 was Cercospora personata which caused sporadic heavy attacks of late leaf-spot. From observation of these attacks it appears that the species is present as several 'races' of varying degrees of pathogenic virulence.

D. McDonald.

Sugar Cane

A foliage disease of sugar cane was examined at Bacita in September. This disease, which was first observed towards the end of August, consisted of 'tip-burning' and 'scorching' of the leaves. The symptoms occurred first toward the tips of the leaves and the lesions spread down to the leaf-sheath in some cases. A number of fungi were found to be associated with the disease but it

appeared doubtful whether they were individually capable of initiating the disease. It is possible that the disease was caused by excessive transpiration as the condition became manifest after a period of dry weather.

D. McDonald.

Sorghum

A 'stalk-rot' disease of sorghum was recorded at Kwali. This disease was very similar to a stalk-rot of the crop recorded in the U.S.A. where it is attributed to weakly parasitic fungi and bacteria entering the plant tissues through damaged areas of the stalks. Such damage is usually caused by insect attack or unfavourable weather conditions.

No significant varietal resistance to this disease was noted but it was evident that high applications of nitrogen rendered plants more susceptible to attack.

D. McDonald.

Soyabean

No important disease attack was observed on this crop. Soyabean Mosaic Virus was recorded but at a very low incidence. Bacterial leaf-spot due to Xanthomonas phaseoli var sojense was of common occurrence but it is unlikely that yields were reduced as the disease was present in a very mild form.

D. McDonald.

Other Records

Sorghum : Head smut (Sphacelotheca reiliana) at Samaru and Maigana.
Loose grain smut (Sphacelotheca cruenta) at Samaru
Covered smut (Sphacelotheca sorghi) at Misau.

Millet (Pennisetum typhoides) : Green ear (Sclerospora graminicola) at Samaru and Zonkwa.

Bambara groundnuts (Voandzeia subterranea) : Wilt (Sclerotium rolfsii) at Ilorin.

Cowpeas (Vigna sinensis) : Virus (mosaic, mottling, vein clearing, vein banding, leaflet distortion) was general.
Powdery mildew (Oidium sp.) at Samaru.

Groundnuts : Wilt (Sclerotium rolfsii) at Birnin Kebbi and K

Maize : Leaf sheath rot, pathogen not yet isolated, at Osara

C.T. Pyne and A.S. Fatmi.

ENTOMOLOGY

Introduction

The completion of some entomological investigations has enabled other projects to be started. Following the work on storage pests of millet and sorghum, a recommendation for control has been forwarded to the Ministry for consideration. Attention is now being given to the small-scale storage of maize, wheat and cowpeas, and to the problems of the dried fish trade of Lake Chad. Work on groundnut rosette has ceased at Samaru, but continues at Mokwa, where the incidence of the disease is more serious. Detailed studies of the field pests of cowpeas have revealed the main insects concerned, and have shown that substantial yield increases are possible when these are controlled. Cotton insecticide trials, and research on the biology of the red bollworm have continued.

M.A. Choyce.

Groundnut Entomology - Samaru

Trials at Samaru, Kano and Kafinsoli confirmed the results obtained at Samaru in 1961. Early sowing and close spacing consistently gave the highest yields of both kernels and haulms. Close spacing, unlike early sowing, did not reduce the number of rosetted plants or the number of aphids per acre but only increased the number of healthy stands per unit area and thus the yield. In the trial at Kafinsoli, no rosette at all appeared in the crop but early sowing and close spacing still outyielded other treatments showing that under all conditions from nil to heavy rosette attack this treatment will give the highest yield. Full details of this work will be published elsewhere.

R.H. Booker

Groundnut Entomology - Mokwa

The problem of high rosette incidence and low yield in late planted groundnuts was studied in two trials; a spacing trial with plant population from 10,890 to 174,24 stands per acre and a trial combining plant populations of 23,240 and 46,480 stands per acre, different ridge widths and selective weeding treatments. These trials showed that with late planting some control of rosette could be obtained and yield increased by using plant populations of approximately 46,500 stands per acre. These trials and previous spacing trials showed that increasing the plant population of late planted groundnuts (late May - early June) decreased the number of rosette infections per acre.

The 1961 results, together with those from 1958 to 1960, show that to grow groundnuts successfully in the Riverain provinces early planting and close spacing are essential. Early plantings, whilst escaping rosette disease and giving maximum yields, require harvesting during the wettest months and in consequence the crop needs drying. Successful trials were carried out during 1961 using a drier constructed of local materials, with low capital and running costs. The drier, however, used wood fuel which may not be readily obtainable in all parts of the Riverain Provinces. A system of cultivation of groundnuts as a cash crop can be outlined as a result of these findings. The system requires early planting, not only to escape rosette disease, but also to avoid the marked loss of yield which results from late planting even in the absence of disease. For optimum results therefore a recommended variety should be planted not later than two to three weeks after the first rains; plantings should be made on ridges with

a spacing to give 20,000 - 25,000 stands per acre and a seed rate of two seeds per stand should be used. The crop should be harvested at optimum maturity and artificially dried.

A series of observations in the field on the life history of Aphis craccivora Koch, the vector of rosette virus, was continued in 1961. At Mokwa it appears that volunteer groundnuts do not play an important role in the carry-over of the disease and vector during the dry season. The aphid appears to migrate from the groundnut crop at the end of the season on to a number of wild hosts, principally Euphorbia hirta L., and survive the dry season on these hosts. These plants inhabit cultivated or recently cultivated land and are associated with disturbed soil. The carry-over of the virus and the vector appears therefore to occur in cultivated areas rather than in the "bush". In May and June, after the beginning of the rains the aphides appear to migrate from these hosts to the same or similar host species and infect the groundnut crop in passage. The aphides do not settle and breed on the crop until August, and only from August onwards is there marked secondary spread of the disease within the crop.

A trial on the effect of date of infection on yield was not conclusive in 1961, but previous trials have indicated that only infections occurring in the first ten weeks after planting seriously reduce yield. During this period only primary infections occur with the virus being brought into the crop from outside.

J. A'Brook.

Cowpea Entomology

Field pests. More detailed investigations this year at Samaru have confirmed that damage by pests has a marked influence on the yield of cowpeas and that the major damage to the crop occurs after flowering and fruiting has commenced. The pests doing most damage are the coreills, Acanthomia brevirostris Stål, Acanthomia horrida Germ., and to a lesser extent Anoplocnemis curvipes (Fabr.). These feed on the young pods causing premature drying and shrivelling of the pod with complete loss of yield. Observations have shown that over 80 per cent of the pods can be destroyed in this way. Other major pests are Maruca testulalis Gerst., whose larvae feed in the flowers causing flower shedding, and also in the pods; Coryna hermanniae Fabr., which feeds on flowers also causing shedding, and Piezotrachelus varium (W.) whose larvae feed within the seeds. A spraying trial planted in mid July included treatments with a DDT/BHC mixture at 1 lb DDT and 0.1 lb BHC per acre, and with Sevin at 1 lb per acre, applied at weekly intervals for six weeks, the first immediately after flowering commenced. Both treatments effectively controlled all the major pests, although Sevin was not so effective as DDT/BHC in controlling Maruca testulalis. In the sprayed plots only one per cent of the pods were shrivelled as compared with 30 per cent in the unsprayed plots. Both treatments completely eliminated Piezotrachelus varium. Flower and pod pests were so effectively controlled that the average number of pods harvested for each plot in the sprayed plots averaged 90 in the DDT/BHC treatment, 75 in the Sevin treatment and only three in the unsprayed plots. Final yields of threshed beans were 1,429 lb per acre in the DDT/BHC treatments, 1,172 lb per acre in the Sevin treatment and 23 lb per acre in the control. Spraying shortened the flowering and fruiting period of the plant. Sprayed plants, although producing far more pods died whilst the unsprayed plants were still green.

Observations on three crops of cowpeas sown in mid June, mid July and mid August indicated that the first sowing suffered more from

coreid attack and less from attack by P. varium than the latest sowing. M. testulalis was at a similar level in all three sowings. The two major pests of the crop before flowering, Ootheca mutabilis Sahlb., a leaf eater and Alcidodes leucogrammus Er., a stem girdler were absent on the latest sowing. These two pests, although sometimes serious, are not normally of great importance.

R.H. Booker.

Field and Storage Pests. Infestation by the major storage pest Callosobruchus maculatus (F.) begins in the field but is at a very low level, less than one per cent of seeds being attacked. It has been shown, however, that this low level of infestation is sufficient to start store infestation and weight losses of 45 per cent after three months storage have been recorded. There were indications that spraying can reduce the level of pre-harvest infestation. Two other bruchids, Bruchidius atrolineatus Pic. the most common bruchid in the field, and Collosobruchus rhodesianus Pic. also occur in the field but do not persist long into the storage period.

R.H. Booker.

Pests of legumes other than cowpeas. The general pest complex that attacks cowpea is found on most other legumes. A crop of Phaseolus aureus was severely attacked by O. mutabilis but this was effectively controlled using Sevin. The same pest wiped out twelve acres of soyabean at Daudawa.

R.H. Booker.

Storage Entomology

Sorghum and millet. A series of trials at twenty-one sites throughout the country has shown that the 'sandwich' treatment of 0.5 per cent lindane dust at the rate of 10 p.p.m. threshed grain is often barely economic unless sorghum and millet are stored for longer than six months. This is due to the fact that large infestations do not develop until the height of the rainy season when the moisture content of the grain is high and the temperature low. A Samaru trial has shown that the treatment is also uneconomic if the granary is gradually emptied over a period of nine months.

"Rumbus"* constructed of grass matting or other plant products are poor storage structures because of the ease of cross infestation. It has been recommended that all farmers, except those in some parts of the Riverain provinces, should be encouraged to use mud rumbus. In the humid Riverain provinces, drying of damp crops, such as early maize, is facilitated in grass structures and mud rumbus should generally be discouraged. 10 p.p.m. lindane usually controls insect attack in the grass rumbus but failures may occasionally occur because of substantial loss of the insecticide through the open weave of the walls.

Two formulations consisting originally of 0.5 per cent malathion in kaolin fillers were used in storage trials but were found to decompose rapidly in the high temperatures experienced at Samaru. Work continues with more concentrated dusts based on other types of diluents.

Unthreshed sorghum stored in clean mud rumbus covered with

Rumbu. (Hausa) Grain store.

insect proofing was less damaged by stored product insects than the stored in unproofed rumbus. Light infestation of Sitotroga cerealella (Oliv.), Sitophilus oryzae (Linne), Rhyzopertha dominica (Fauv.), Tribolium confusum J. du V., Oryzaephilus mercator (Fauv.) and Cryptolestes sp. occurred; these infestations had originated before harvest. The absence of wasps indicates that the normal high rate of parasitism of the above species normally originates after harvest.

In an experiment which consisted of a field of sorghum (var. Short Kaura) planted around a mud rumbu containing heavily infested one year old, unthreshed sorghum, it was found that a variety of stored product insects attacked maturing heads. An overall field infestation of S. cerealella was found eight weeks before harvest. Cryptolestes sp. occurred in small numbers on heads within twenty feet from the source. A uniform light infestation of T. castaneum (Herz), R. dominica, and S. oryzae was found.

These results show that preharvest infestation can be an important factor contributing to the damage in stored sorghum. In areas where the density of human population is high and sorghum is intensively cropped it is doubtful whether storage hygiene measures such as cleaning out the granary and proofing the aperture would have much effect on controlling insect damage. However, in areas where the crop is grown far from the store and thus the residual field infestation is low, store hygiene may be important in helping to control infestation.

The possibility of controlling insect infestation by air-tight storage using slightly modified local storage structures was investigated. The interiors of well built mud rumbus were painted with bitumen solution and then plastered. The rumbus were filled with unthreshed sorghum which was heavily infested and were sealed with earth brick sealed with bitumen. After thirteen months the infestation had increased to a level similar to identical sorghum in rumbus that had not been bitumenised. In another trial infested threshed sorghum was stored in earthenware jars which had been burnished in a variety of ways, and closed with a rubber stopper which was sealed with bitumen solution. Although the intergranular carbon dioxide content rose to two per cent in six months, the infestation increased rapidly.

As a result of the grain storage work, a recommendation has been made to the Ministry that farmers who intend storing millet or sorghum in granaries for periods longer than six months, are encouraged to apply a 'sandwich' treatment of 10 p.p.m. lindane.

P.H. Giles.

Cowpeas. In a Samaru trial untreated and unshelled cowpeas stored for periods of up to twelve months in mud rumbus or earthenware pots were badly attacked by Callosobruchus maculatus (F.) and Bruchidius atrolineatus (Pic.). The damage, which amounted to 30 per cent corrected weight loss, was considerably reduced when the pots were dusted with 10 p.p.m. lindane as a 'sandwich' treatment.

P.H. Giles

Wheat. The application of layers of 0.5 per cent lindane at the rate of 10 p.p.m. in threshed wheat stored in mud rumbus for nine months prevented any measurable weight loss. In the untreated rumbus a heavy infestation of Trogoderma granarium Everts caused severe damage 'heating' and high moisture content. A light infestation of this insect was present when the wheat originally arrived in Samaru from Sokoto.

(P.H. Giles)

Groundnuts. As a result of trials in Tangale Waja Division, Bauchi Province, where unshelled groundnuts are stored for periods up to twelve months for food and seed, farmers are using 0.5 per cent lindane dust to prevent heavy damage by Caryedon gonagra (F.). In practice 5 oz. of 0.5 per cent lindane dust is mixed with 100 lb unshelled groundnuts. This is equivalent to about 16 p.p.m. unshelled nuts. In untreated rumbus 40-50 per cent corrected weight loss may occur in the shelled nuts after twelve months storage.

P.H. Giles

D Dried Fish. A brief survey of the Lake Chad dried fish trade showed that the commodity is badly damaged by Dermites maculatus Deg. and Necrobia rufipes (Deg.). The Dermestes infestation arises as soon as the fish is charred by the Chad fishermen and quickly develops as the produce moves to Eastern and Western Nigeria. Heavy infestation of Calliphorida and Muscid larvae occur before curing.

P.H. Giles

Cotton Entomology.

The year 1961 proved a difficult one for cotton growing. The low rainfall, and early onset of the dry season at the end of September, increased the losses due to pest attack. Plants were unable to compensate for early losses of fruiting points by further growth later in the season, and the absence of a top-crop was particularly noticeable. Where good cultivation methods were combined with efficient pest control, however, reasonable yields were obtained.

In a comparison of different insecticides for control of pests of cotton, similar increases in yield of seed cotton resulted from six applications of DDT (1 lb per acre) plus gamma BHC (0.1 lb per acre) and six applications of Sevin (0.5 lb per acre). Unsprayed cotton yielded 678 lb per acre, and the increase due to spraying averaged 408 lb per acre. Uprooting of every third row of cotton, to allow easier access to the spray operator, did not lead to any reduction in yield.

Four late sprays gave a higher yield (1,330 lb seed cotton per acre) than six early sprays (1,146 lb per acre), but this result requires confirmation as the nearness of sprayed to unsprayed plots may have led to some protective effect on the unsprayed plots, which yielded 768 lb per acre. A combination of early and late sprays increased the yield to 1,564 lb per acre.

Yields of sprayed multiplication cotton at Daudawa Main Farm averaged 760 lb per acre, and were only slightly less than those of last season, in spite of an abnormally low rainfall. In contrast the yield of unsprayed cotton at Shemi, at 190 lb per acre, was less than half that of last season.

A number of cotton demonstration plots were sown in each province, using the latest Samaru recommendations, and including sprayed and unsprayed cotton. Results were again extremely variable, partly because of seasonal effects, partly because of shortage of staff in the Field Services Division of the Ministry often made adequate and continuous supervision impossible.

A number of light traps were in operation throughout the season at Samaru and Daudawa. Flight activity of the red bollworm,

Diparopsis watersi (Roths.), was similar to that of last season, with populations increasing during September to a maximum in early October. At Daudawa, where multiplication cotton was confined to the southern half of the main farm, considerably more moths were caught on the cotton than on the non-cotton block. Flight activity at Daudawa was bi-modal, with a pronounced peak in June - July, in addition to the peak in September - October. This was probably a consequence of the late and sporadic onset of the rains, which resulted in dry conditions early in the season.

A comparison of the catches made by kerosene and mercury vapour light traps shows that reasonable numbers of Diparopsis are attracted to both types. Other pests of cotton and cowpeas appear to be more readily attracted to the mercury vapour lamp.

Studies on the emergence of Diparopsis from short and long term pupae under laboratory and simulated field conditions have continued. The pattern of emergence has been related to rainfall and soil temperature. At Daudawa observations on the rate of parasitism of Diparopsis by the tachinid Carcelia evolvans (Wied.) have shown that this remains at a high level.

At Samaru, observations on leaf rollers, mirids, jassids and stainers were made on those blocks of cotton sown successively at the beginning of June, July and August. Mirids (Campylomma spp.) reached a maximum population in early October, irrespective of sowing date. Leaf rollers (Sylepta derogata (F.)) were confined to the June and July sowings and many parasites, particularly Apanteles syleptae, Ferr. were found. Jassids (Empoasca fascialis (J.)) became most numerous on the July sown plot, at the boundary of the June and July sowings. Stainers (Dysdercus supersticiosus (L.)) moved into the cotton soon after flowering except on the August sowing. All these mobile and exposed pests were effectively controlled by insecticides on other cotton fields at Samaru and Daudawa.

M.A. Choyce, W. Reed and
D.J. de B. Lyon.

Root Knot eelworms

Trials with a soil fumigant have confirmed that control of root knot eelworms would be of economic value in heavily infested areas on such crops as tomatoes and carrots and appropriate recommendations have been made.

W.R. Wilson.

COTTON BREEDING

In yield trials the expression of potential differences was curtailed by the rapid cut off of moisture at the end of the rains. Consequently there have been no spectacular results from the programme of selection and testing this season.

District Variety Trials.

The results of the District Variety Trials did not give any consistent indication that the new mixture or selections were going to be of immediate value as successors to 26 J New Blend.

Strains Test and Small Bults Test

These tests compared strains, selections and hybrids developed at Samaru. Some of the hybrids gave appreciable increases in yield of seed cotton, but they were all below the standard required in other character, such as ginning percentage or lint length.

S.52 Selections - Selection Index.

The selection index technique was used for the sixth successive year in the analysis of, and selection within, the progenies of the family S.52.

A total of nine strains was included, representing progenies selected from last season's material, some on the basis of high yield alone and others on the results of the selection index. No conclusive evidence was obtained as to which method was the most successful.

Emanating from last season's experience, the number of controls has been increased from two to seven, this being the theoretical optimum for an experiment of this design.

S.56 Selections - Special Character Progenies.

This season the second stage of the tandem selection programme was commenced. The criteria used for selecting these three groups of progenies previously, namely, high ginning percentage, high yield and high lint length, was changed. The first two groups are now selected for high yield and high ginning percentage respectively; the third has been divided into two further groups, selection in one is for high ginning percentage and in the other for high yield.

Correlations between the characters followed the pattern of the previous season, except for lint yield and lint length, which showed no correlation as compared with a negative one last season.

S.56 - Modal Bulk.

A modal and a positive bulk were again tested in a replicated trial. No difference could be demonstrated between them, despite the different selection pressures maintained over three generations.

Hybridization.

Because the hybrids produced from earlier hybridization programmes had not proved successful, a further programme was commenced in 1960, and has been expanded this season. The major objectives are to produce material not only higher yielding but with lint qualities to suit possible future demands and with resistance to Xanthomonas malvacearum (bacterial blight). The material used for the crosses includes varieties from Uganda, the Republics of the Sudan, Niger and Tchad as well as existing strains from Samaru.

The initial crosses were also made between the 26 J strains used at Samaru in the mixtures, to assess their combining quality.

D.A. Lawes, B.J.S. Lee,
B. Costelloe, J.L. Palmer.

CROP PHYSIOLOGY

Climate and General.

The total rainfall at Samaru for 1961 was 32.45 inches which is the lowest ever recorded. Reference to Appendix II shows that July and especially August were below average in total rainfall but the same was not true of number of days fall. After the planting dates of the major crops there was only one period without rain as long as four days. The last fall of the season was on 22nd September; there was then an abrupt change to conditions of lower temperatures and humidities.

The lower than average rainfall was not associated with clear sunny days (see sunshine hours) and the important months could not generally be described as "good growing weather". The effect of the weather on crop growth was that for crops passing their critical moisture requirement before the cessation of the rains there was no serious shortage of rain despite the low total. For cotton, on the other hand, even very early planting hardly gave the crop time to yield properly before the moisture supply ceased. Consequently it was to be expected that cultivation treatments modifying the soil moisture status had more apparent effect on cotton than on sorghum and groundnuts.

Cotton

Maximum Yield Plots. The original cotton monocropped plot gave its highest yield yet, 2,687 lb seed cotton per acre. The consistently high yields obtained here are in part due to the extreme uniformity of growth over the plot which is itself dependent on the uniform deep rooting of the crop. The same deep rooting gave the crop an additional reservoir of moisture to tap when the rains ceased; the excellent yield was therefore able to mature. The annual yields for this plot are given in Table IV.

TABLE IV. Maximum yield plot of monocropped cotton.

Year	Seed Cotton lb per acre	Rainfall inches
1957	1,930	54.9
1958	2,246	35.0
1959	2,206	41.9
1960	2,540	43.0
1961	2,687	32.5

On the new maximum yield plots this uniformity was not obtained and the crop was not so well rooted. The overall plot yield was 1,449 lb seed cotton per acre, but sub-plots from within the area ranged from 1,899 to 1,143 lb per acre.

Very high yields of cotton have, in the past, always followed dressings of organic manure. Two plots known to have received no organic manure during at least the last decade, were cropped this season without organic manure. These plots again did not yield uniformly; one yielded 1,430 lb seed cotton per acre, including variations between sub-plots of from 2,090 to 995 lb per acre, and the other on a very poor piece of land, averaged 1,278 lb seed cotton

per acre, but contained a range of from 1,526 to 1,097 lb per acre.

Replicated Trials. In previous seasons all trials with cultivation techniques have been of an annual nature using a different site each season. As there is a strong possibility that the effect of such treatments and rainfall conservation measures may be cumulative, a permanent trial was laid down where cultivation treatments at two levels of fertility remain on the same plots from season to season but the three main crops are rotated through them each year.

The trial containing the cotton was unprotected against insect pests and adjacent to another plot of cotton similarly unprotected and very early planted. Insect pest damage was, therefore, heavy and the comparisons between methods of rainfall conservation were inconsistent although the improvement of all methods over open free draining furrows was too large to be masked. The mean of all conservation treatments at the high level of fertility was 848 lb seed cotton per acre as compared with 681 lb per acre for free draining furrows. Comparative. Figures for the low level of fertility were 794 and 591 lb seed cotton per acre respectively.

An experiment designed to study the importance of the stage of growth of the plants' reaction to the bad effects of surface flooding did not give conclusive results as there was little surface flooding this season.

The optimum plant population was again investigated for cotton under conditions of the 'new' levels of fertility at three planting dates. There was no indication that closer spacing than that at present recommended gives higher yields under these conditions. Early planting even at a low level of fertility gave higher yields than late (17th July) planting at a high level of fertility.

orghum

Maximum Yield Plot. The maximum yield plot of Short Kaura yielded 4,303 lb grain per acre.

Replicated Trial. The first year of the permanent experiment discussed under cotton was badly attacked by cockchafer larvae (Melolonthidae) and extensive supplying with transplants was necessary. Growth was hence erratic and the results obtained were inconclusive.

roundnuts

Maximum Yield Plot. Samaru 38 variety yielded 1,425 lb kernels per acre; this was no more than the comparison plot which did not receive many of the treatments yet yielded 1,455 lb per acre. The haulm yield, however, was considerably heavier on the maximum yield plot being 1,905 lb per acre as compared with 978 lb per acre on the comparison plot.

Replicated Trial. The replicated trial substantiated the results of the maximum yield plot. There were no differences in the yields of kernels (which were of the same order as those from the maximum yield plot), between either cultivation treatments or fertility levels. There were no differences between the yields of haulms from the different levels of fertility, but there were between different cultivation treatments. Whether the extra haulms (from 20 - 50 per cent) is sufficiently valuable to justify the extra cultivations even requires further investigation.

Meteorology and Soil Moisture Studies

A constant recording Kipp solarimeter was installed in January 1961. The records of radiation from this are being used in the computation of evapotranspiration losses at Samaru.

Further data on the moisture holding capacities of the soils on the station have been obtained.

Analysis of meteorology data has continued.

D.A. Lawes.

CHEMISTRY SECTION

Routine Work.

A total of 4,500 soil samples have been analysed for organic carbon, total nitrogen, total phosphorus, organic phosphorus, total sulphur, "available" bases (sodium, potassium, calcium and magnesium), cation exchange capacity and mechanical analysis in connection with soil surveys (2,500) and agronomic trials (2,000). Forty water samples were analysed to assess suitability for irrigation.

Over 1,000 samples of fodders and feeding stuffs were analysed for proximate constituents and determination of carotene and vitamins have been conducted on 200 milk and blood samples.

Soils

Organic carbon and nitrogen. After ten years of continuous cultivation without addition of fertilizers or farmyard manure the organic C and total N contents of the soil were reduced to 10-20 per cent and 20-30 per cent of the levels under bush fallow respectively. Application of farmyard manure at 3 and 5 tons per acre for ten years have maintained the organic C content at about 50 per cent of bush fallow levels.

With increasing applications of farmyard manure, the rate of organic C loss was greater than that of N:

Farmyard manure (tons/acre)	0	1	2	3
C loss (as % C added)	-	76.7	83.8	83.2
N loss (as % N added)	-	62.8	50.5	42.5
C/N	11.9	14.0	12.4	11.7

Application of superphosphate with farmyard manure enhanced the effect of the latter in maintaining the level of organic C. Similar results have not been obtained with sulphate of ammonia which also failed to increase the N content of the soil. When both fertilizers were applied together there was an appreciable increase in both organic C and N.

Mulching with groundnut shells resulted in an increase in both organic C and total N.

Water soluble N is correlated with mineralisable N ($r = 0.85$; $P = 0.01$). Since water soluble N is more easily determined and more reproducible the method may be used in predicting mineralisable N.

E. Jones.

Sulphur. In the absence of free sulphate, total S content of soils studied ranged from 10-180 p.p.m. S, with mean values of 40-50 p.p.m. Values varied in relation to organic C and, more particularly to total N. levels. Mean C/S and N/S ratios were 103 ± 10 and 7.5 ± 0.5 respectively. Very low C/S ratios (< 50) were invariably due to free sulphate.

Incubation trials showed that sulphate added to a soil in the presence of excess organic C and nitrate N was quantitatively incorporated into the organic fraction. Under the same conditions phosphate was found to accelerate the rate of uptake; but, in the absence of either added organic C or nitrate N, addition of phosphate enabled recovery of more sulphate than the amount originally added. Although this implies mineralisation of organic C, the mineralisation was not demonstrated by ordinary incubation methods and the increase in sulphate may be attributed to anion exchange.

Incubation studies on the uptake / mineralisation of sulphate are being pursued further in order to understand the relation of sulphur to other soil factors and to correlate data obtained with field responses.

Sulphur deficiency in groundnuts has been investigated in conjunction with fertilizer trials on the crop. Results have not been very successful due partly to the very small number of trials showing significant sulphur effects and further investigation are in progress.

Pot trials have shown that sulphur deficiency in groundnuts is associated with failure to nodulate efficiently in addition to the obvious visual symptoms.

R.G. Heathcote.

Phosphorus. Attempts to relate total soil $P(P_T)$, organic $P(P_O)$ and 0.2 N sulphuric acid extracted $P(P_A)$ with data from fertilizer trials have not been successful.

Recoveries of P as P_A from soils to which P was added at rates of 8, 16, 32 and 64 p.p.m. using KH_2PO_4 , amounted to a constant proportion of P added and were independent of time.

Incubation experiments have failed to show evidence of mineralization. Added P was incorporated in the organic fraction in the presence of added nitrate and organic matter.

Fractionation of P in ridge and furrow profiles showed that P_O was uniform throughout the cultivated layer and P_A values were high only at the site of superphosphate application.

P_O values were determined in profiles of similar soil from a cultivated and a bush fallow area. In both profiles P_O decreased with depth. In the fallow soil the ratios C/P_O and N/P_O also decreased with depth. At the surface the P_O values of the fallow soil were lower than those of the cropped soil.

Analysis of P content of grain and residues of sorghum and groundnuts produced the following results:

<u>Sorghum</u>	% P	<u>Groundnuts</u>	%P
Grain	0.1-0.2	Kernels	0.20-0.26
Leaves	0.02-0.04	Stalks & leaves	0.1 -0.2
Stalks	0.01-0.04	Shells	0.03-0.07

D.R. Homer

ANIMAL AND PASTURE SECTION

Animal Nutrition

Nutritive Value of Fodders. The most useful criteria for assessing the nutritive value of fodders are digestible organic matter (DOM), digestible crude protein (DCP) and relative intake expressed in lb dry matter (DM) per 100 lb live weight. Since DCP levels are often too low to satisfy the maintenance requirements of the animal, the relationship between DCP intake and nitrogen balance has been studied. With fresh herbage this relationship is represented by the equation:

$$Y = 19.47 + 9.02 x$$

where Y is expressed in grams of DCP per 100 lb LW and x the N balance in grams. A DCP intake of 19.47 grams is required to provide maintenance and is being used as the criterion for selecting fodders for dry season seeding.

The nutritive value of conserved fodders has been studied during the year using dry cows and the results are given in Table V.

TABLE V. Nutritive Value of Conserved Fodders.

	DOM %DM	DCP %DM	Relative Intake lb/100 lb LW	DCP Intake g/100 lb LW
Cowpea/maize silage	61.4	4.0	1.13	20.5
- do - (prewilted)	59.1	4.3	1.21	23.6
Cowpea/maize silage (prewilted large scale)	55.1	4.5	1.31	26.8
Mucuna/sorghum silage	49.6	2.0	1.43	13.0
- do - (prewilted)	53.6	2.7	1.54	18.9
<u>Andropogon gayanus</u> (fresh herbage)	53.6	2.9	1.36	17.9
- do - silage	53.8	2.7	1.55	19.0
- do - silage (pre- wilted)	47.3	1.2	1.40	7.6
- do - hay	44.9	0.71	1.71	5.4
Bush grass foggage	48.7	0.95	0.79	3.4
Cowpea hay	65.1	9.4	1.54	67.2
- do - haulms	54.4	9.2	1.42	58.0

With the exception of one cowpea/maize mixture which was ensiled on a farm scale, all silages were prepared in small pit silos with a capacity of nine tons fresh material. The higher nutritive value of the cowpea/maize mixture compared with that of mucuna/sorghum agrees with the previous years' findings.

The Andropogon gayanus was cut in early August when the humidity was high. The low nutritive values of the hay and prewilted silage may be attributed to mould growth caused by the slow and inefficient natural drying. The effort involved in this method of conservation is not justified when the results of the bush grass foggage sample cut in February - March are compared.

The cowpea hay sample was cut in early November and lower nutritive value of the samples of haulms harvested in mid January is apparent only with respect to DOM.

Factors affecting the Accuracy of Digestibility Data. A full replicated trial was conducted to study the accuracy in detecting small differences in digestibility of materials and whether nutritive values of separate roughages are additive when fed as a mixture. Nine dry cows were fed the following rations in groups of three in a randomised block design over three consecutive periods of seventeen days.

L Mucuna hay
C Sorghum hay
L/C A 1:2 mixture of L and C.

Digestibility data.

	DOM	DCP	Relative Intake
	(%DM)	(%DM)	(lb/100 lb LW)
L	52.07	7.11	1.87
C	53.57	1.48	1.70
L/C (calculated)	53.07	3.36	1.76
L/C (determined)	53.47	4.07	1.83

The advantage of feeding a legume/cereal mixture is apparent with respect to DCP. The reduced digestive efficiency of the animals in the second and third periods is evident from the following results:

Period	DOM	DCP	Relative Intake
1	54.9	5.22	1.84
2	53.6	4.03	1.87
3	50.6	3.41	1.55

Roughage/Concentrate Mixtures for Fattening. The low intake of feed by White Fulani cattle is a limiting factor in attaining rapid live weight gains. Generally speaking low intakes are associated with low digestibility and the effect of increasing the digestibility by feeding a high level of concentrates and reduced roughage was studied.

Eighteen dry cows were divided between two groups A and B and fed Shika Fattening Concentrate Mixture at 1.25 and 1.75 lb per 100 lb live weight respectively. Groups A and B were each subdivided between three sub groups AS, AH, ASH, BS, BH, and BSH which were fed silage (cowpea/maize), hay (mucuna) and a 50/50 (DM basis) mixture of silage and hay ad lib respectively. The relative DM and digestible DM intakes of the respective groups were as follows:

Subgroup	DM (lb/100 lb LW)	DDM (lb LW)
A _S	2.23	1.51
A _H	2.15	1.37
A _{SH}	2.16	1.39
B _S	2.96	1.90
B _H	2.41	1.59
B _{SH}	2.70	1.78

Group B animals showed significantly increased intakes and hay alone was the least satisfactory roughage.

Utilization of Bush Foggage as Dry Season Fodder. In view of the high cost of growing and conserving forage crops for dry season feeding, investigations are in progress to study the nutritive value of bush foggage harvested in the dry season. A preliminary digestibility trial (*vide supra*) showed that cut foggage was very low with respect to DCP and intake but DOM was of an order which compares favourably with many silages and hays. Since DCP and intake can be boosted with concentrates the effect of varying levels of supplementary concentrates at 0, 2, 4 and 8 lb/head/day were studied in a replicated trial using twelve dry cows. The relative total intakes, relative roughage intakes and DM digestibilities were as follows:

Concentrates (lb/head/day)	Relative Intake (Total)	Relative Intake (Roughage)	DM Digestibility
0	0.96	0.96	52.9
2	1.18	0.95	57.3
4	1.40	0.94	59.0
8	1.76	0.81	61.21

The intake of roughage was only slightly reduced with increasing concentrate feeding and total intake was positively correlated with DM digestibility.

The Effect of Feeding Cottonseed on the Rate of Carotene and Vitamin A Depletion in the Dry Season.

Reports from America have suggested that an antivitamin A factor is present in cottonseed and can cause deficiency under rangeland conditions where the intake of carotene is low. Since cottonseed is used widely in stock feeding, an experiment was conducted to study the significance of American findings in Northern Nigeria.

The experiment in progress involves 16 calves of one to two years which are allocated to four treatments:

- A. Bush foggage + 3 lb cottonseed/head/day.
- B. - do - - do - + 2 oz palm oil.
- C. - do - + 3 lb groundnut cake/sorghum, (1:5).
- D. - do - - do - + 2 oz palm oil.

Rations A and C are carotene-free and the 2 oz palm oil provides 20 ug carotene. Live weight gains for the first 120 days amounted to 0.57, 0.51, 0.42 and 0.61 lb/head/day for A,B,C, and D respectively. Mean carotene and vitamin A levels in blood serum at the beginning and after 133 days in mg/100 ml were:

Group	0		133	
	Carotene	Vitamin A	Carotene	Vitamin A
A	8	9.3	67	18
B	12	19	384	63
C	18	14	28	19.5
D	12.5	7	536	53.7

Carotene and vitamin A levels in blood serum do not indicate an increase in depletion due to cottonseed. The slight increase groups A and C may be attributed to the animals' access to green pasture when weighed.

Levels of Carotene and Vitamin A in Cows Milk and Blood during Ear Lactation and the Effect of Carotene-rich Supplements.

Carotene and vitamin A levels in blood and milk of twelve cow post partum and on the following treatments were studied:

- A. Normal management
- B. - do - + 2 oz palm oil/head daily after calving
- C. - do - + 2 oz palm oil/head daily beginning 3 weeks before calving.

The experiment was started in early March when the carotene content of the pasture was lowest. Although the carotene supplements resulted in increased levels of carotene and vitamin A in the blood, there was no difference in milk levels between treatments.

Vitamin A levels in colostrum averaged 34.7 ug/100 ml. The average carotene and vitamin A contents of milk were 13.5, 14.2, 14.7, 15.8 and 11.8, 14.9 for groups A, B and C respectively. There is a definite indication that supplementary feeding of vitamin A or carotene direct to the calf would be beneficial since secretion in the milk is low after the colostrum stage although blood levels are comparatively high.

T.B. Miller.

Long-Term Feeding Trial. The long-term trial to demonstrate the potential production of White Fulani Cattle has been continued. Forty-eight animals were divided into two groups each of twelve bulls and twelve heifers which were maintained on a high and moderate plane of nutrition from weaning.

The calves were reared according to the Shika Management System which has been found to produce an unchecked growth-rate curve. High plane animals were fed supplements at a level approximately 20 per cent higher than the moderate ones. The treatments were maintained until:

- a) the bulls were stall-fed to "finish" for slaughter, and
- b) the heifers were brought in for steaming-up prior to calving.

<u>Heifers</u>	<u>High</u>	<u>Moderate</u>
Mean age at calving (years)	2.71	2.79
Live weight before calving (lb)	711	717
Live weight gain (lb/head/day)	0.68	0.66
Calf birth weight	45	40

Although the rates of live weight gain were good and the calvings normal, the milk yields were very poor and below farm average. Three heifers on high plane and one on the moderate plane have dried off before the 100th day of lactation. Mean yields at two weeks after calving were 4.0 and 3.2 lb/head/day for high and moderate planes respectively.

The results have shown that in comparison with local practice, it is possible to produce an extra calf which is desirable from the viewpoint of beef production.

<u>Bulls</u>	<u>High</u>	<u>Moderate</u>
Age at slaughter (years)	2.86	2.99
Live weight (lb)	955	964
Live weight gain (lb/head/day)	0.886	0.836
Dressing percentage	60.7	59.8
Good cuts (% carcass)	36.6	37.3
Cheap cuts (% carcass)	48.3	46.6
Tenth rib analysis:		
Bone (% rib)	16.7	17.3
Water (% edible tissue)	57.4	62.5
Protein (% edible tissue)	16.7	16.7
Fat (% edible tissue)	24.8	18.8

The results to date indicate only slight differences between treatments with respect to rate of live weight gain and fat percentage.

Baby Beef Production.

An experiment is in progress to investigate the possibility of rearing White Fulani bull calves on an all concentrate ration similar to the system which has been successfully developed at the Rowett Institute.

Twenty-four bull calves have been allocated to the following treatments:

- A. Suckled up to six months and fed concentrates only.
- B. " " " " " " " " " + roughage.
- C. Housed from birth and bucket-fed + concentrates only.
- D. " " " " " " " " " + roughage.

Shika fattening mixture formed the concentrates and high quality elephant grass (20 per cent protein) was fed as roughage.

Early results indicate that roughage is necessary if the calves have been suckled for six months outdoors. This may be expected since the animals have had access to pasture which would encourage rumen development.

Treatment B appears to be the most successful with a mean live weight of 317 lb at 220 days or 1.24 lb gain/head/day.

T.B. Miller, and R.J. Thorpe.

Tick Control - Cattle. The following results have been obtained from spraying trials designed to compare the efficiency of acaricides under conditions where Ambylomma variegatum, Bodophilus annulatus, Rhipicephalus simus simus and Hyalomma trunc are present.

Acaricide	% active ingredient	% kill 1 day after spraying dry season	wet season
1. Toxaphene	0.37	98.7	75.4
2. Gamma BHC	0.05	90.1	66.3
3. Sevin	0.125	58.6	51.2
4. Ronnel	0.4	not included	39.8

- | | |
|--------------------------|---------------------|
| 1. Cooper's Coopertox | 2. Cooper's Gamatox |
| 3. Union Carbide - Sevin | 4. Dow - Nankor 44E |

The residual effect of the acaricides was investigated toxaphene was shown to be the most satisfactory in both the dry and wet seasons with respect to both residual control and kill on spraying.

A toxaphene spraying routine weekly during the wet season and three weekly during the dry season is recommended. A full account of this work will be published elsewhere.

R.J. Thorpe.

Urea Feeding Trial. The dry season performance of ten young bulls and ten young heifers fed on a normal concentrate ration was compared to the performance of a similar group of animals fed on a ration in which part of the natural protein had been substituted by urea. Both the rations were balanced for digestible nutrients

Weight of concentrates fed per head per day (oz).

	Groundnut cake	Sorghum	Urea
Nil Urea	14	7	Nil
Urea	6	14	1

Liveweight gain over a period of 98 days (lb)

	Males	females	means
Nil Urea	58.6	22.4	40.5
Urea	31.4	27.1	29.2
	S.E. $\pm$ 6.7		S.E. $\pm$ 4.7
Means	45.0	24.7	
	S.E. $\pm$ 4.7		

Although the liveweight gains of the two groups were not statistically significantly different, the animals fed on the urea supplements appeared to be in a worse condition than the animals fed on the natural protein ration at the end of the trial.

As the cost of the ration containing urea is higher when expressed in terms of cost per unit liveweight gain, and as there are readily available supplies of natural protein concentrates in Northern Nigeria, the use of urea to supplement cattle concentrate rations cannot be advocated.

R.J. Thorpe.

The effect of Terramycin Feed Supplements on the Growth Rate of Bucket Fed White Fulani Calves. Twelve bull and twelve heifer calves were allocated to two treatment groups:

- (1) bucket fed from birth to 6 months plus 50 ug active oxytetracycline hydrochloride per head per day.
- (2) bucket fed from birth to 6 months plus nil oxytetracycline hydrochloride per head per day.

The calves were reared following the Shika bucket-feeding calf management system, the terramycin being fed daily in the morning milk ration.

Liveweight at weaning (lb)

	Males	Females	Means
With terramycin	197.9	181.1	189.5
Without terramycin	177.1	156.5	166.8
	S.E. $\pm$ 7.9		S.E. $\pm$ 5.6
Means	187.5	168.8	
	S.E. $\pm$ 5.6		

When weaned at six months old the liveweight of the calves on the terramycin supplemented group was statistically significantly higher than the liveweight of the calves on the control group at the 5 per cent level of probability. Both males and females responded equally well to the supplement the mean rate of liveweight gain being increased by 13.6 per cent from 0.65 lb per head per day in the control group (normal for the herd) to 0.77 lb per head per day in the supplemented group.

As the maximum possible rate of liveweight gain is essential at this age in an intensive beef producing herd, the use of terramycin feed supplements is recommended where a bucket-feeding management

routine is being followed.

R.J. Thorpe.

* Pfizer 5.5% Terramycin Animal Formula Soluble Powder.

* R.R.S. Newsletter Vo. 27, Nov. 1960.

Sorghum/Mucuna (Stizolobium spp.) interplanting trial. To obtain a silage crop of sorghum and mucuna with a fresh crop weight ratio of from 1.5 to 2.0 sorghum : 1 mucuna (the limits for safe ensilage) interplanting, with the cereal and legume grown on alternate ridges and the legume planted two weeks after the cereal, will give a twelve per cent increase in yield of digestible crude protein (equivalent to 1 lb DCP per acre statistically significant at the 1% level of probability) over an equivalent area straight cropped and mixed at harvest.

The increase in yield of DCP results from an increase in the yield of mucuna (20.4 per cent increase over control statistically significant at the 5 per cent level of probability), whilst the sorghum yield is unaffected (1.7 per cent decrease from control not significant).

Other methods of interplanting give equally good yields of DCP, but all give unsatisfactory cereal/legume weight ratios for ensilage. Simultaneous planting allows the legume to become dominant regardless of whether the crops are interplanted down or across the ridge, and the cereal/legume ratios are too narrow to make a good silage. With delayed planting of the legume the cereal becomes well established. Interplanting down the ridge allows the cereal to become too dominant, but interplanting across the ridge gives an ideal crop balance.

Treatment	Yield DCP lb per acre			Crop Ratio
	Sorghum	Mucuna	Total	Sorghum/mucuna
Interplanted across ridge simultaneous planting	108	379	487	0.71 : 1
Interplanted across ridge delayed planting	186	286	472	1.61 : 1
Interplanted down ridge simultaneous planting	135	344	479	0.98 : 1
Interplanted down ridge delayed planting	220	219	439	2.49 : 1
Control - mixed at harvest	167	258	425	1.61 : 1

S.E. of totals ± 6

Although maize (Pennisetum typhoides)/ mucuna mixtures intercrop satisfactorily they should not be used in this zone as the yield of DCP per unit area is low.

Work is continuing on the application of the technique to maize/mucuna mixtures, to compare the yield of DCP per unit area with that from maize and cowpea grown separately and mixed at harvest. The latter has given the best quality silage of those examined to date.

R.J. Thorpe.

Grassland Investigation.

Work continues with the investigations into the maintenance of fertility under grassland systems of farming, the establishment and management of pasture and fodder crops, and investigation into rangeland management. Work on selection and improvement of suitable forage species is now at a standstill. Investigations on plants for hedging started on a small scale during the year at Shika; other than this no new work has been undertaken.

The fertility investigations are necessarily long term and the results will not be available for some years. The present series of experiments investigating temporary and permanent pastures, when the pastures are grazed and the farmyard manure proportional to the quantity of material removed by the animal is returned to arable crops in the rotation, has only completed one six year rotation. Compared with other treatments the crops following the pastures are good but fertility was known to be high at the start of the trial and before any comparisons can be made the trial will have to pass through a number of rotation cycles. Trials comparing the application of fertilizers to permanent and temporary grass and pastures with the application of the same amount of fertilizer to the arable crops have indicated that the fertilizer is more effective when applied direct to the crops. Trials in which fertilizer has been applied to grass fallow as a method of improving soil fertility in Northern Nigeria indicate that this method is not likely to meet with success.

Work on the establishment and management of pasture continued mainly on Andropogon gayanus. The beneficial effects of soil consolidation was confirmed in a trial carried out during the course of the year. As reported last year, the use of a cambridge roller before sowing achieved satisfactory results. In 1961, on soils of moderately heavy texture, an excellent cover was obtained by rolling after sowing. This could replace pre-sowing rolling. On light soils, however, it is probably more advisable to roll before sowing and cover with a chain harrow. Brushwood harrows are recommended as preferable to hand raking especially where adapted to bullock or man power.

Rangeland investigations into the effects of burning and grazing continues. These include trials investigating practical methods of management which have been going on for a number of years at Shika and others which have only recently started at Katsina in the Sudan Zone and on the Jos Plateau. The argument for burning of rangeland after the first rains is now well known. This gives better control of regenerating bush than burning in the dry season and is less harmful to the perennial grasses. In order to obtain sufficient combustible material it is necessary to limit grazing in the previous year. This aspect was investigated together with the intensity of the burn by a new method using thermocolour paints. It would appear that where there is an even distribution of combustible material 700 - 1,000 lb dry matter per acre will produce a burn capable of checking low scrub; for controlling taller scrub and trees 1,500 - 2,500 lb of dry matter per acre is required.

J.H. Davies.

SOIL SURVEY SECTION

During the year the organization of the section in four soil survey field teams and one vegetation survey field team was maintained. This system which was introduced last year, continued to function with increasing efficiency, both senior and junior staff benefiting from previous years' experience.

In reconnaissance soil survey greater use has been made of aerial photographs, both in the production of the final maps, and in the preliminary planning of field operations. It has been possible to increase the detail, and the utility of the soil maps, with little increase in field work. In vegetation survey the recently introduced quantitative methods continued to work satisfactorily.

By the end of the year the field work on the reconnaissance survey of the eight half degree sheets in the Potiskum - Damaturu Kwaya - Gombe area was virtually completed, and a considerable amount of the information gained had been written up. During the year one team completed the Potiskum (86) and Damaturu (87) sheets and a second team was working in Wuyo (153). The section has made advances in mapping methods and in soil classification since this survey was started in 1958 and because of this, revision of parts of the Nafada, Mutwe, Gulani and Gombe sheets was carried out during the year.

Two soil survey teams were occupied throughout the year in assessing the suitability of several proposed experimental farm sites. In each case this was done by a sub-reconnaissance survey of a large area followed by a detailed survey of the proposed farm site. Thus a large part of Katagum Division (Bauchi Province) was surveyed to determine the suitability of a site at Azare, and a very rapid sub-reconnaissance survey of central Adamawa was accompanied by detailed surveys of farms at Kofare (Yola) and Jalingo. A sub-reconnaissance survey of parts of northern Adamawa and northern Sardauna Provinces was undertaken to find suitable experimental farm sites. A detailed survey of about 500 acres at Bokkos (Plateau Province) was carried out during the 1961 wet season.

The vegetation survey of the Gombe area was completed during the year with the field work on the Gulani and Nafada sheets and analysis of the data from the whole area.

The section was involved in the organization of the 4th C.R.O.A.C.U.S. conference which was held in Samaru in November, 1961. To cooperate in the CTA/CSA joint project for a Soil Map of Africa, a new classification of Northern Nigerian soils, at great soil group level was produced in December, 1961.

D.M. Ramsay and P.R. Tomlinson.

AGRICULTURAL ENGINEERING SECTION

Development.

The development of the ox-drawn implements designed at Samaru in 1960 continued and a total of 80 implements of various types were manufactured and distributed to provinces. Three of the implements are now considered ready for commercial exploitation, viz:-

Tie-ridging (basin listing) attachment for Emcot ridger.
Lightweight Tie-ridger / weeder.
Wheeled Groundnut Lifter.

An improved ox yoke has been designed and has proved successful in preliminary trials. The Multi-Purpose tool frame has proved highly successful for several operations but further development is required. A specification was issued for a standard farm cart and experiments made with wooden bearings and with a very simple cart supplied by F.A.O.

The front-mounted toolbar for the Ferguson 65 tractor was improved by the addition of an isolating valve in the hydraulic system and of diabolo depth-control rollers for ridge splitting. Semi-rotary tie-ridger units were fitted to the rear toolbar: these units produce a compact, erosion-resistant tie and the spacing between ties can be varied to suit experimental requirements. This machine was used for off-season cultivations and completed 70 acres between March 12th and March 30th.

A set of conversion parts was designed to enable the Exhaust-operated Locust Sprayer to be fitted to any Land Rover in the field, without special tools. Detailed fitting and operating instructions were prepared in collaboration with the Entomology Section.

A study was made of the feasibility of using commercial warm-air driers (such as the Scotmec, Trojan, Lister, etc.) for drying hay and haylage at Shika and proposals for modifying an existing building were prepared.

Testing.

The test of four makes of groundnut decorticators was completed and a report published. Two machines had completed 6,886 hours, and the other two 1,960 hours, on an electrically driven test rig; their reliability was exceptionally good. All the decorticators required about 0.14 horsepower, which is more than one man can supply continuously, and types with a handle suitable for two operators are preferred.

Tests were made with two small water pumps, the Penson Marlow $1\frac{1}{2}$ inch and the Ilo-Regal $1\frac{1}{2}$ inch: the reports included recommended operating, servicing and fault-correcting procedures. The David Brown Albion Hurricane forage harvester was tested and a report issued; one point of interest was that all stem borers were killed when sorghum stalks were chopped.

Observations were also made on the Ransome TG 3007 and Massey Ferguson 65 rotary bush slasher, the Bomford and Evershed Superflow cultivator, an American Massey-Harris-Ferguson toolbar and Wright Rain overhead irrigation equipment.

The eight-year-old Massey Harris combine which had previously been used only as a stationary thresher, was used to combine Kaura and Webster's Cross sorghums, soya bean and pigeon pea. A working rate of 0.75 acres per hour was achieved in a crop of Webster's Cross at Shika.

A Russell Planter was used to plant about 60 acres of mucuna for hay. Two N.I.A.E.-type tie-ridgers were mounted between the planter units and the implement showed considerable promise but difficulty was experienced with the seed-dropping mechanism. (The units were an obsolete type and the manufacturer's agent states that the latest models would be satisfactory).

Cultivations.

The mechanical cultivations at Samaru are still experimental: the problems of direct-splitting of ridges have not all been solved

and about one-third of the fields were ploughed and/or reredged. It is increasingly obvious that cultivation is an art, not a science - each combination of rainfall and soil type requires its own technique and the judgment of the supervisor is more important than the choice of machines.

The 'standard' technique, so far as one exists, is as follows

- (i) Dry season ripping and tie-ridging to encourage infiltration of early rains - front or rear mounted toolbar on Ferguson 65 tractor.
- (ii) Application of superphosphate - Ferguson multi-purpose seed drill (fertilizer section only) with Ferguson 35 tractor.
- (iii) Application of farmyard manure - Atkinson farmyard manure spreader with Ferguson 35 tractor and Ferguson 35 tractor with Hi-Lift loader.
- (iv) Direct splitting of ridges - front or rear mounted toolbar on Ferguson 65 tractor (4 rows).
- (v) Tie-ridging - N.I.A.E.-type tie ridger on Ferguson 35 tractor (or semi-rotary units when combined with operation (iv)).

Miscellaneous.

The construction of the Tractor Drivers School was completed and one beginners' course held before the School was handed over to the School of Agriculture in June, 1961: a total of four courses had been organised by the Agricultural Engineering Section since the inception of the Tractor Driving School in 1960.

The Samaru dam was completed in May, 1961 and the spillway was redesigned to increase the area of fadama which could be irrigated by gravity. The irrigation system was designed and its construction supervised. Owing to the low rainfall, the lake did not fill to the spillway level.

D.W.M. Haynes.

LIBRARY

This year has undoubtedly been the busiest yet in the library. Loans rose by 546 to a total of 2,659 for the year but the figures show that provincial staff borrowed 100 fewer publications than in the previous year and so the increase was carried by increased internal borrowing. The book and microfilm stock increased as far as funds permitted, with over 400 new books and 106 microfilms, bringing the total to 3,591 books and 392 microfilms. Pamphlets, which are usually obtained free, rose by 650.

In January, 1962, 282 periodicals were being received and with the arrival of a photocopying machine during the year an experiment was started whereby the contents pages of six of the most widely read journals were photocopied and copies circulated in place of the journal. This has been satisfactory and the photocopies, on return to the library, are sent to Mokwa and Ilorin.

One hundred and ninety two volumes were bound, nearly 100 books repaired and other smaller jobs were undertaken by the bookbinder.

During the year the Ministry Newsletter has been issued monthly, **three** Technical Reports have been issued and **fourteen** Samaru Research Bulletins have been published.

P.M.J. Edwardes.

Appendix I

PUBLICATIONS

1.4.61 - 31.3.62

- BOOKER, R.H. 1961. Insect Pests of Citrus. Technical Report No. 19 R.R.S., Ministry of Agriculture, Northern Nigeria.
- 1961. Oecophylla longinoda Latr. (Formicidae) and its association with Coccus hesperidum L. (Coccidae) in Northern Nigeria. Trop. Agriculture, Trin., 38(3), 251-256.
- CHOYCE, M.A., REED, W. 1961. Pupal Cell of the Red Bollworm. Emp. Cott. Gr. Rev., 38(3), 182-188.
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- CLAYTON, W.D. 1961. Derived Savanna In Kabba Province, Nigeria. J. Ecol., 49(3), 595-604.
- DRANSFIELD, M. 1961. Effect of Dalapon on Cotton Seedlings. Emp. Cott. Gr. Rev., 38(3), 192-199.
- FOSTER, W.H. 1961. Note on the Establishment of a Legume in Rangeland in Northern Nigeria. Emp. J. exp. Agric., 29(116), 319-320.
- , MUNDY, E.J. 1961. Forage Species in Northern Nigeria. Trop. Agriculture, Trin., 38(4), 311-318.
- GILES, P.H. 1962. The Storage of Guineacorn and Millet by Farmers in Northern Nigeria. Technical Report No. 20. R.R.S., Ministry of Agriculture, Northern Nigeria.
- HARRIS, K.M. 1961. The Sorghum Midge Contarinia sorghicola (Coq) in Nigeria. Bull. ent. Res., 52, Part 1, 129-146.
- HIGGINS, G.M. 1961. Experimental Rain Coverage in Northern Nigeria. Nigerian Geog. J., 4(2), 11-25.
- KING, H.E. 1961. Nigerian Cotton Production. Studies of Factors Affecting Cotton Yields, International Cotton Advisory Committee. Doc. II, XX, revised, 67-72. Washington.
- LAWES, D.A. 1961. A Method of Labelling Plants. Emp. Cott. Gr. Rev. 38(1), 50.
- 1961. Rainfall Conservation and the Yield of Cotton in Northern Nigeria. Emp. J. exp. Agric., 29(116), 307-318.
- 1962. Recent Investigations in Crop-Water Relations in Northern Nigeria. Proceedings of the Science Association of Nigeria. 1 - 3, 1958-60, 31-32. Ibadan.
- MAURER, A.R., GOLDSWORTHY, P.R., MEREDITH, R.M. 1961. Clip Cards for Experiments. Technical Report No. 18. R.R.S., Ministry of Agriculture, Northern Nigeria.
- MILLER, T.B. 1961. Studies on the Nutrition of Zebu Cattle in Northern Nigeria. 1. Energy Intake and Milk Production. Emp. J. exp. Agric., 29(115), 230-244.

- ILLER, T.B. 1961. A Preliminary Study of the Importance of Carotene in the Supplementary Feeding of Cattle during the Dry Season in Northern Nigeria. *W.afr.J.biol. Chem.*, 4(4), 66-70.
1961. Recent Advances in Studies of the Chemical Composition and Digestibility of Herbage. *Herb. Abstr.* 31(2), 1-9.
- UNRO, J.M. and others. 1962. Progress Report from Experiment Stations, Season 1960-61, Northern Nigeria. Empire Cotton Growing Corporation, London.
- ULLAN, R.A. 1962. Report on the Reconnaissance and Detailed Soil Surveys of the Birnin Kebbi Area. Soil Survey Bulletin No. 10. R.R.S., Ministry of Agriculture, Northern Nigeria.
- ED, W., CHOYCE, M.A. 1961. Observations on *Carcelia evolvans* (Wied.) (Diptera, Tachinidae), a parasite of *Dipropsis watersi* (Roths.) (Lepidoptera, Noctuidae), in Northern Nigeria. *Bull. ent. Res.*, 52(4), 785-793.
- TANTON, W.R. 1961. Food Crop Preferences: Their Significance to Plant Breeding Programmes and Agricultural Research Policy. *W. afr. J. biol. Chem.*, 4(4), 84-89.
- TORY, R.L. 1961. Report on the Selection of a Site for a Proposed Agricultural Experimental Farm in Igala Division, Kabba Province, Northern Nigeria. Soil Survey Bulletin No. 13. R.R.S., Ministry of Agriculture, Northern Nigeria.
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The Northern Region Agricultural Research Programme - Research in Agriculture: 1959.

The Regional Research Station: a Visitor's Guide to Samaru, 1961.

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No. 1. September 1958 - No. 43. March, 1962.

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- No. 1. A Key to Nigerian Grasses. W.D. Clayton, 1960.
- No. 2. The Breeding of White Fulani Cattle at Shika, Nigeria. W.H. Foster, 1960.
- No. 3. The Effect of Feeding high Protein and high Carotene Concentrates to young Cattle during the late Dry Season - Early Wet Season in Northern Nigeria. T.B. Miller, 1960.
- No. 4. Some effects of Gibberellic Acid on Cotton. M. Dransfield, 1961.
- No. 5. Distortion of Guineacorn (Sorghum vulgare) caused by a Mealy Bug Heteroecoccus nigeriensis Williams in Northern Nigeria. E. Harris, 1961.
- No. 6. A Preliminary Study of the Importance of Carotene in the Supplementary Feeding of Cattle during the Dry Season in Northern Nigeria. T.B. Miller, 1961.
- No. 7. The Sorghum Midge, Contarinia sorghicola (Coq.) in Nigeria. K.M. Harris, 1961.
- No. 8. Food Crop Preferences: their Significance to Plant Breeding Programmes and Agricultural Research Policy. W.R. Stanton, 1961.
- No. 9. Oecophylla longinoda Latr. (Formicidae) and its association with Coccus hesperidum L. (Coccidae) in Northern Nigeria. R.H. Booker, 1961.
- No. 10. The Pupal Cell of the Red Bollworm. M.A. Choyce and W. Reed. 1961.
- No. 11. Effect of Dalapon on Cotton Seedlings. M. Dransfield, 1961.
- No. 12. Studies on the Nutrition of Zebu Cattle in Northern Nigeria. I. Energy Intake and Milk Production. T.B. Miller, 1961.
- No. 13. Recent Advances in Studies of the Chemical Composition and Digestibility of Herbage. T.B. Miller, 1961.
- No. 14. Forage Species in Northern Nigeria. W.H. Foster and E.J. Mundy, 1961.

TECHNICAL REPORTS

- No. 5. Report on studies of soil-water-crop relationship at Samaru, 1956. D.A. Lawes, 1957.
- No. 6. Interim report on further work on crop physiology. Seasons 1957-58 and 1958-59. D.A. Lawes, 1959.
- No. 7. A bibliography of cowpeas. D.G. Faris, 1959.
- No. 8. The standard DNPk experiments. J.K. Obi, 1959.
- No. 13. Notes on nursery practices. D.W.T. Clay, 1960.

- No.14. Notes on tomato leaf spot caused by Septoria lycopersici Speg. W.R. Stanton, 1960.
- No.15. Methods of applying superphosphate to groundnuts. P.R. Goldsworthy, 1961.
- No.16. Citrus Nursery practices. A. Bruno, 1961.
- No. 17. Fertilizers in Northern Nigeria Current utilisation and recommendations for their use. K.A. Watson, 1961.
- No.18. Clip Cards for experiments: the method used at the Regional Research Station, Samaru, for the classification of experiment records. A.R. Maurer, P.R. Goldsworthy, and R.M. Meredith, 1961.
- No.19. Insect pests of citrus. R.H. Booker, 1961.
- No.20. The storage of guineacorn and millet by farmers in Northern Nigeria. P.H. Giles, 1962.

SOIL SURVEY BULLETINS

- No. 1. A Preliminary Soil Report on the Lafiagi Tree Crop Project. (Ilorin Province).
pp 22 3 maps G.M. Higgins, 1957.
- No. 2. A Preliminary Soil Survey Report on the Afaka Forest Reserve Experimental area. (Zaria Province).
pp 10 2 maps P.R. Tomlinson and W.D. Clayton, 1957.
- No. 3. A Preliminary Soil Report on the Bacita Fadama. (Ilorin Province).
pp 22 2 maps G.M. Higgins, 1958.
- No. 4. A Preliminary Report on the Detailed Soil and Contour Survey of Mokwa Experimental Farm Site, with a Report on Vegetation of Map Sheet 181, N.W. Mokwa. (Niger Province).
pp 17 3 maps G.M. Higgins, W.A. Hope and W.D. Clayton, 1959.
- No. 5. A Preliminary Report on the Detailed Land, Soil and Contour Survey of the Riverain School of Agriculture, Kabba, and a Reconnaissance Ecological Survey of Western Kabba Province.
pp 17 5 maps G.M. Higgins, A.P. Fleming and W.D. Clayton, 1959.
- No. 6. A Preliminary Report on the Reconnaissance Soil and Vegetation Survey of an Area near Wushishi (Niger Province).
pp 13 3 maps W.D. Clayton and W.A. Hope, 1959.
- No. 7. Report on the Reconnaissance Soil and Vegetation Survey of part of the Jema'a Resettlement Scheme. (Zaria Province).
pp 26 3 maps W.D. Clayton and W.A. Hope, 1960.
(Appendix 8 pp + 1 map by W.A. Hope, in production).
- No. 8. Report on the Second Soil Survey of the Bacita Fadama. (Ilorin Province).
pp 26 4 maps G.M. Higgins, D.M. Ramsay and R.L. Story, 1960.

- No. 9. Report on the Selection of a Site for a Proposed Agricultural Experimental Farm near Zuru. (Niger Province)
pp 14 1 map R.L. Story, 1960.
- No.10. A Report on the Climate, Soils and Vegetation of the Niger Trough.
pp 71 G.M. Higgins, D.M. Ramsay and R.A. Pullan, 1960.
- No.11. Report on the Detailed Soil Survey of the Livestock Investigation Centre, Katsina, and the Reconnaissance Survey of the Surrounding Area. (Katsina Province).
pp 66 4 maps P.R. Tomlinson, 1960.
- No.12. Reconnaissance Report, Map Sheet 51, Gummi. (Sokoto Province).
pp 61 2 maps P.R. Tomlinson, 1961.
- No.13. Report on the Selection of a Site for a proposed Agricultural Experimental Farm in Igala Division. (Kabba Province).
pp 22 2 maps R.L. Story, 1961.
- No.14. Report on the Reconnaissance and Semi-detailed Soil Surveys undertaken in North East Bornu, 1960.
pp 66 9 maps G.M. Higgins, D.M. Ramsay, R.A. Pullan and P.N. de Leeuw, 1960.
(part III detailed soil descriptions, in production).
- No.15. Report on a rapid Reconnaissance Soil Survey of the Mambilla Plateau (Sardauna Province).
pp 23 A.W.S. Mould, 1960.
- No.17. Report on the Reconnaissance and Detailed Soil Surveys of the Birnin Kebbi Area. (Sokoto Province).
pp 69 4 maps R.A. Pullan, 1961.

Appendix II.

STAFF OF THE RESEARCH AND SPECIALIST SERVICES DIVISION

31.3.62.

Acting Chief Research Officer: G.M. Higgins, B.Sc.(Wales),
D.A.S., D.T.A.

Acting Deputy Chief Research Officer: A.B. Rains, B.Sc.(Wales),
D.A.S.

Acting Principal Research Officer: K.A. Watson, B.Sc.Agr. (Syd.)

Acting Principal Research Officer: R.E. Wyatt, B.Sc.(Lond.)
D.A.S., D.T.A.

Agronomy Section

Officer in Charge: P.R. Goldsworthy, B.Sc.(Leeds), D.Ag., D.T.A.
R.M. Meredith, B.Sc.(Durh.)
P. Walker, B.A. (Camb.), D.M.S.

Botany Section

Officer in Charge D.L. Curtis, B.Sc.(Read.), D.T.A.
Officer in Charge, Mokwa, C. Harkness, B.Sc.(Birm.), D.A.S., D.T.A.
D.J. Andrews, B.Sc.(Wales), D.A.S., D.T.A.
R.W. Gibbons, B.Sc.(Durh.), D.A.S., D.T.A.
W.C. Stonebridge, B.Sc.(Lond.), D.A.S.
D.A. Guymer, B.A. (Camb.).
A. Bruno, D.S.A. (Padova).
J. Henson.
O.A. Inyang.

Plant Pathology Section

Officer in Charge C.T. Pyne, B.Sc.(Wales), M.Sc.(Nott.), D.A.S.
D. McDonald, B.Sc.(St.A.), D.A.S., D.T.A.
M. Dransfield, B.Sc., Ph.D. (Nott.)
Alhaji A.S. Fatmi, B.Sc., M.Sc.(Agra),
D.A.I.A.R.I. (New Delhi).

Cotton Breeding Section

Officer in Charge D.A. Lawes, B.Sc.(Wales).
B.E. Costelloe, B.Sc.(Durh.).
J.L. Palmer, B.Sc.(Wales).

Grain Legume Section

Officer in charge W.R. Stanton, B.Sc.(Read.), Ph.D.(Lond.).

Entomology Section

Officer in Charge and Senior Empire Cotton Growing Corporation
Officer

M.A. Choyce, B.Sc.(Nott.), D.I.C.

R.H. Booker, B.Sc.(Wales), D.A.S., D.T.A.

P.H. Giles, B.Sc.(Nott.), D.A.S., D.I.C.

J. A'Brook, B.Sc. (Lond.), D.A.S., D.T.A.

D.J. de B. Lyon, B.Sc.(Lond.).

S.O. Oyidi, B.Sc.(Lond.) (On study leave).

S.A. Toye, B.Sc.(Lond.). (" " ").

Crop Physiology Section

Officer in Charge

D.A. Lawes, B.Sc.(Wales).

W.M. Steele, B.Sc.(Durh.), D.A.S.

Chemistry Section

Officer in Charge

T.B. Miller, B.Sc., Ph.D. (Aberd.).

D.R. Homer, B.Sc.(Birm.).

R. Heathcote, B.Sc.(Wales).

Mm. Ahmed Jarra, B.Sc., B.Agr.(Q.U.B.).

A.J. Bennett, H.N.C.(Chem.).

L.E. Iduma.

O.T. Eshett, A.I.S.T. (Lond.).

Animal and Pasture Section

Officer in Charge

J.H. Davies, B.Sc.(Wales).

R.J. Thorpe, B.Sc.(Nott.), D.T.A.

Engineering Section

Officer in Charge

D.W.M. Haynes, B.Sc.(Edin.), A.M.I.Ag.E.

K.C. Baxter, B.Sc.(Agr.)(Durh.), N.D.Agr.E.
D.T.A.

J. Edward.

A. Stokes.

P. Phillp.

Soil Survey Section

Officer in Charge

D.M. Ramsay, B.Sc., Ph.D.(Edin.).

P.R. Tomlinson, B.Sc.(Birm.).

W.A. Hope, B.Sc.(Edin.).

K. Klinkenberg, Geog. Drs. (Amsterdam).

R.L. Story, M.A. (Lond.).

R.A. Pullan, M.Sc.(Birm.).

P.N. de Leeuw, L.I. (Wagenigen).

H. Whitehead, A.M.A.S.E.E.

Library

Officer in Charge Miss P.M.J. Edwardes, B.Sc.(Lond.).

Farm Staff

Samaru S.O. Abodunde.

Mokwa J.U. Ohaeri.

Administration

Acting Finance Staff Officer J.G.O. Woghiren

Acting Executive Officer G.B.A. Udok.

Acting Stores Officer A.E. Igboin.

Personal Assistant Mrs. A.B. Henson.

The following officers left the Division during the period 1.4.61 to 31.3.62.

A.R. Maurer,	Principal Research Officer.	Resigned
W.H. Foster,	Specialist Officer.	"
E.J. Mundy,	Agricultural Officer.	"
T. Rossiter,	Specialist Officer.	"
D.W.T. Clay,	Specialist Officer.	"
Mrs. E. Harris,	Temporary Specialist Officer.	"
E. Jones,	Specialist Officer	"
P.H. Goldberg,	Research Superintendent.	"
T.E.S. Palmer,	Senior Agricultural Engineer.	"
Mrs. B. Jones,	Personal Assistant.	"
T.M. Munro,	Senior E.C.G.C. Officer.	Transferred to Uganda.
S.J.S. Lee,	E.C.G.C. Plant Breeder.	" " Ibadan.
V. Reed,	E.C.G.C. Entomologist.	" " Tanganyika.
D. Oliver,	Agricultural Officer.	" " Field Services.
E. Ugha,	Agricultural Supt.	Transferred to Agricultural Training.
O. Aparu,	Agricultural Officer.	Transferred to Field Services.
P. Wolton,	Agric. Supt. (Mech.).	Transferred to Agricultural Training.
J.R. Mitchell,	" " "	Transferred to Irrigation Division.
G. Horner,	" " "	Transferred to Agricultural Training.
G. Seaman,	" " "	Transferred to Irrigation Division.
H. Bain,	Senior Fisheries Officer	Transferred to Field Services.
Cross,	Fisheries Officer	Transferred to Field Services.
A. A. Adehi,	Stores Officer.	Transferred to Headquarters.

MONTH	RAINFALL (INCHES)		DAYS FALL		RELATIVE HUMIDITY %		AIR TEMPERATURE OF (°C)		SUNSHINE DAILY MEAN (HOURS) (1)		OPEN PAN EVA- PORATION (INCHES) (2)					
	1961	Average 1924 to 1961	1961	Average 1938 to 1961	1961	Average 1954 - 1961	1961	Average 1938 - 1961	1961	Average 1954 to 1961	1961	Average 1954 to				
JAN.	0.28	0.01	1	0.1	17.7	14.7	19.5	15.7	86.9	58.6	88.1	57.6	8.2	8.9	6.78	7
FEB.	0.00	0.06	0	0.3	12.3	9.8	15.4	11.1	83.5	58.1	90.9	60.5	8.6	9.5	7.74	7
MAR.	0.23	0.37	1	1.0	17.6	13.9	28.0	16.0	91.3	63.6	95.8	67.0	8.9	9.0	9.75	8.95
APRIL	1.47	1.33	4	3.7	42.5	28.8	52.9	31.0	95.4	69.7	96.9	71.0	7.6	7.9	7.73	7.44
MAY	2.27	5.16	5	10.5	51.6	32.4	62.5	42.2	94.5	70.8	91.3	70.1	8.5	8.5	8.36	7.28
JUNE	8.19	6.41	14	13.0	72.9	60.3	74.6	60.0	85.6	67.1	87.7	68.0	7.4	8.0	6.82	5.90
JULY	5.68	8.62	22	16.2	86.3	69.5	80.0	67.9	81.7	65.8	83.3	67.2	5.2	5.8	4.45	4.86
AUGUST	4.81	11.39	17	20.3	80.7	72.2	82.3	70.9	80.0	66.5	81.9	66.9	4.3	4.9	4.07	4.41
SEPT.	9.52	9.08	14	16.8	74.6	60.3	76.5	63.6	84.1	63.0	84.8	66.5	7.0	6.6	5.53	5.15
OCT.	0.00	1.39	0	4.4	47.2	27.7	59.3	42.6	89.3	60.6	88.9	63.2	10.0	9.1	6.17	5.68
NOV.	0.00	0.04	0	0.2	18.5	14.5	30.9	20.3	88.7	56.9	90.0	62.5	10.6	10.0	6.76	6.36
DEC.	0.00	0.00	0	0.0	16.1	13.2	22.7	17.1	81.3	50.8	87.6	57.5	9.2	9.5	4.17	6.40
TOTALS	32.45	43.86	78	86.5	-	-	-	-	-	-	-	-	-	-	78.33	77.59
MEANS	-	-	-	-	44.3	34.8	50.4	38.2	86.9	62.8	89.0	64.7	8.0	8.1	6.53	6.47

(1) Campbell - Stokes sunshine recorder.

(2) From sunken tank 6' x 6'; not corrected for errors due to splash.